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INDEX TO VOLUME XXXIX.

April to September, 1910.

LEADING ARTICLES.

Abbot, Gen. Henry L. Hydraulics of the Chagres River . . . 377
Aeroplane Motors—French (Illustrated) *Warren H. Miller* . . 881
Aeroplanes, French—The Manufacture of (Illustrated) *Warren H. Miller* 649
Africa—Railway and Engineering Progress in (Illustrated) *J. Hartley Knight* 1
Air Conditioning of Factories—The Heating, Ventilating and (Illustrated) *Percival Robert Moses* 697, 865
Allowances for Depreciation—The Ethics of *L. S. Randolph* . 692
Application of Low-Pressure Steam Turbines to Compressor Work (Illustrated) *J. W. Sheperdson* 237
Basis for Laying Out Industrial Plants—The Routing Diagram as a (Illustrated) *Charles Day* 809
Battleship Florida—The United States (Illustrated) . . . 385
Briquetting Industry—The Fuel (Illustrated) *Charles L. Wright* 46, 195
Building of the Institution of Civil Engineers—The New (Illustrated) 822
Bunnell, Sterling H. Humidifiers, their Principles and Useful Applications (Illustrated) 389
Bureau of Mines—The United States 581
Centrifugal Pumps, High-Lift—The Design, Construction and Operation of (Illustrated) *Franz zur Nedden* . . . 55, 214
Chagres River—Hydraulics of the *Gen. Henry L. Abbot* . . 377
Church, A. Hamilton Organisation by Production Factors (Illustrated) 77
Civil Engineers—The New Building of the Institution of (Illustrated) 822
Claydon, Victor R. Time Keeping and Labor Distribution in the Foundry (Illustrated) 221, 402, 549, 859

Compensation of Workmen and Efficiency of Operation (Illustrated) *H. L. Gantt* 17. 161, 331

Compressor Work—Application of Low-Pressure Steam Turbines to (Illustrated) *J. W. Sheperdson* 237

Concrete, Reinforced—Industrial Uses of (Illustrated) *M. M. Sloan* 69

Construction and Operation of High-Lift Centrifugal Pumps—The Design, (Illustrated) *Franz zur Nedden* 55, 214

Cost of Living: Has it Risen, and Why (Illustrated) *Alex. Del Mar* 569

Costs of Machine-Tool Operations in Steam-Engine Manufacturing *William O. Webber* 729

Costs, Power—A Practical Study of *William O. Webber* . . 230

Day, Charles Metal-Working Plants and their Machine-Tool Equipment (Illustrated) 364, 535

Day, Charles The Routing Diagram as a Basis for Laying Out Industrial Plants (Illustrated) 809

Del Mar, Alex. The Cost of Living: Has it Risen, and Why (Illustrated) 569

Depreciation—The Ethics of Allowances for *L. S. Randolph* . 692

Design, Construction and Operation of High-Lift Centrifugal Pumps (Illustrated) *Franz zur Nedden* 55, 214

Efficiency of Operation—The Compensation of Workmen and (Illustrated) *H. L. Gantt* 17, 161, 331

Efficiency Principles—Government Specifications. An Example of Neglect of Three *F. Percival* 853

Efficiency—The Twelve Principles of *Harrington Emerson* . . 321, 481, 679, 841

Engineering Progress in Africa—Railway and (Illustrated) *J. Hartley Knight* 1

Engine Manufacturing, Steam—Costs of Machine-Tool Operations in *William O. Webber* 729

Engines, Steam—The Revival of the Reciprocating (Illustrated) *R. J. S. Pigott* 555, 713

Ethics of Allowances for Depreciation *L. S. Randolph* . . 692

Example of Neglect of Three Efficiency Principles—Government Specifications. An *F. Percival* 853

Fabrication of Fireclay—The Mining and (Illustrated) *A. S. B. Little* 511

Factories—The Heating, Ventilating and Air Conditioning of (Illustrated) *Percival Robert Moses* 697, 865

Factors, Production—Organisation by (Illustrated) *A. Hamilton Church* 77

Fireclay—The Mining and Fabrication of (Illustrated) *A. S. B. Little* 511

Fires, Furnace—Irregularities in *Arthur S. Mann* 89

Florida—The United States Battleship (Illustrated) . . . 385

FOUNDRY—TIME KEEPING AND LABOR DISTRIBUTION IN THE (Illustrated) *Victor R. Claydon* 221, 402, 549, 859
FRENCH AEROPLANE MOTORS (Illustrated) *Warren H. Miller* . . 881
FRENCH AEROPLANES—THE MANUFACTURE OF (Illustrated) *Warren H. Miller* 649
FUEL-BRIQUETTING INDUSTRY (Illustrated) *Charles L. Wright* . 46, 195
FURNACE FIRES—IRREGULARITIES IN *Arthur S. Mann* 89
Gantt, H. L. THE COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION (Illustrated) 17, 161, 331
GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE (Illustrated) *Frank Koester* 24, 176, 340, 494, 659, 825
GOVERNMENT SPECIFICATIONS. AN EXAMPLE OF NEGLECT OF THREE EFFICIENCY PRINCIPLES *F. Percival* 853
HEATING, VENTILATING AND AIR CONDITIONING OF FACTORIES (Illustrated) *Percival Robert Moses* 697, 865
Hess, Henry MANUFACTURING PROFITS AND LOSSES (Illustrated) . 892
HIGH-LIFT CENTRIFUGAL PUMPS—THE DESIGN, CONSTRUCTION AND OPERATION OF (Illustrated) *Franz zur Nedden* . . . 55, 214
HUMIDIFIERS, THEIR PRINCIPLES AND USEFUL APPLICATIONS (Illustrated) *Sterling H. Bunnell* 389
HYDRAULICS OF THE CHAGRES RIVER *Gen. Henry L. Abbot* . . . 377
HYDROELECTRIC-ENGINEERING PRACTICE—A GENERAL REVIEW OF (Illustrated) *Frank Koester* . . . 24, 176, 340, 494, 659, 825
INDUSTRIAL PLANTS, LAYING OUT—THE ROUTING DIAGRAM AS A BASIS FOR (Illustrated) *Charles Day* 809
INDUSTRIAL USES OF REINFORCED CONCRETE (Illustrated) *M. M. Sloan* 69
INSTITUTION OF CIVIL ENGINEERS—THE NEW BUILDING OF THE (Illustrated) 822
IRREGULARITIES IN FURNACE FIRES *Arthur S. Mann* 89
Knight, J. Hartley RAILWAY AND ENGINEERING PROGRESS IN AFRICA (Illustrated) 1
Koester, Frank A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE (Illustrated) 24, 176, 340, 494, 659, 825
LABOR DISTRIBUTION IN THE FOUNDRY—TIME KEEPING AND (Illustrated) *Victor R. Claydon* 221, 402, 549, 859
LAYING OUT INDUSTRIAL PLANTS—THE ROUTING DIAGRAM AS A BASIS FOR (Illustrated) *Charles Day* 809
Little, A. S. B. THE MINING AND FABRICATION OF FIRECLAY (Illustrated) 511
LIVING—THE COST OF: HAS IT RISEN, AND WHY (Illustrated) *Alex. Del Mar* 569
LOW-PRESSURE STEAM TURBINES—APPLICATION OF, TO COMPRESSOR WORK (Illustrated) *J. W. Sheperdson* 237
MACHINE-TOOL EQUIPMENT—METAL-WORKING PLANTS AND THEIR (Illustrated) *Charles Day* 364, 535

Machine-Tool Operations in Steam-Engine Manufacturing—Costs of *William O. Webber* 729

Mann, Arthur S. Irregularities in Furnace Fires 89

Manufacture of French Aeroplanes (Illustrated) *Warren H. Miller* 649

Manufacturing Profits and Losses (Illustrated) *Henry Hess* 892

Manufacturing, Steam-Engine—Costs of Machine-Tool Operations in *William O. Webber* 729

Metal-Working Plants and their Machine-Tool Equipment (Illustrated) *Charles Day* 364, 535

Miller, Warren H. French Aeroplane Motors (Illustrated) 881

Miller, Warren H. The Manufacture of French Aeroplanes (Illustrated) 649

Mines, Bureau of—The United States 581

Mining and Fabrication of Fireclay (Illustrated) *A. S. B. Little* 511

Moses, Percival Robert The Heating, Ventilating and Air Conditioning of Factories (Illustrated) 697, 865

Motors, Aeroplane—French (Illustrated) *Warren H. Miller* 881

zur Nedden, Franz The Design, Construction and Operation of High-Lift Centrifugal Pumps (Illustrated) 55, 214

New Building of the Institution of Civil Engineers (Illustrated) 822

Operation, Efficiency of—The Compensation of Workmen and (Illustrated) *H. L. Gantt* 17, 161, 331

Operation of High-Lift Centrifugal Pumps—The Design, Construction and (Illustrated) *Franz zur Nedden* 55, 214

Operations in Steam-Engine Manufacturing—Costs of Machine-Tool *William O. Webber* 729

Organisation by Production Factors (Illustrated) *A. Hamilton Church* 77

Percival, F. Government Specifications. An Example of Neglect of Three Efficiency Principles 853

Pigott, R. J. S. The Revival of the Reciprocating Steam Engine (Illustrated) 555, 713

Plants, Industrial—The Routing Diagram as a Basis for Laying Out (Illustrated) *Charles Day* 809

Plants—Metal-Working, and their Machine-Tool Equipment (Illustrated) *Charles Day* 364, 535

Power Costs—A Practical Study of *William O. Webber* 230

Practical Study of Power Costs *William O. Webber* 230

Principles, Efficiency—Government Specifications. An Example of Neglect of Three *F. Percival* 853

Principles of Efficiency—The Twelve *Harrington Emerson* 321, 481, 679, 841

Production Factors—Organisation by (Illustrated) *A. Hamilton Church* 77

Profits and Losses—Manufacturing (Illustrated) *Henry Hess* 892

Progress in Africa—Railway and Engineering (Illustrated) *J. Hartley Knight* 1

Pumps, High-Lift Centrifugal—The Design, Construction and Operation of (Illustrated) *Franz zur Nedden* . . 55, 214

Railway and Engineering Progress in Africa (Illustrated) *J. Hartley Knight* 1

Randolph, L. S. The Ethics of Allowances for Depreciation . . 692

Reciprocating Steam Engine—The Revival of the (Illustrated) *R. J. S. Pigott* 555, 713

Reinforced Concrete—Industrial Uses of (Illustrated) *M. M. Sloan* 69

Review of Hydroelectric-Engineering Practice—A General (Illustrated) *Frank Koester* . . . 24, 176, 340, 494, 659, 825

Revival of the Reciprocating Steam Engine (Illustrated) *R. J. S. Pigott* 555, 713

River, Chagres—Hydraulics of the *Gen. Henry L. Abbot* . . 377

Routing Diagram as a Basis for Laying Out Industrial Plants (Illustrated) *Charles Day* 809

Sheperdson, J. W. Application of Low-Pressure Steam Turbines to Compressor Work (Illustrated) 237

Sloan, M. M. Industrial Uses of Reinforced Concrete (Illustrated) 69

Specifications—Government. An Example of Neglect of Three Efficiency Principles *F. Percival* 853

Steam-Engine Manufacturing—Costs of Machine-Tool Operations in *William O. Webber* 729

Steam Engine—The Revival of the Reciprocating (Illustrated) *R. J. S. Pigott* 555, 713

Steam Turbines, Low-Pressure—Application of, to Compressor Work (Illustrated) *J. W. Sheperdson* 237

dy of Power Costs—A Practical *William O. Webber* . . . 230

e Keeping and Labor Distribution in the Foundry (Illustrated) *Victor R. Claydon* 221, 402, 549, 859

rbines, Low-Pressure Steam—Application of, to Compressor Work *J. W. Sheperdson* 237

elve Principles of Efficiency *Harrington Emerson* 321, 481, 679, 841

ited States Battleship Florida (Illustrated) 385

ited States Bureau of Mines 581

Uses of Reinforced Concrete—Industrial (Illustrated) *M. M. Sloan* 69

Ventilating and Air Conditioning of Factories—The Heating, (Illustrated) *Percival Robert Moses* 697, 865

Webber, William O. A Practical Study of Power Costs . . . 230

Webber, William O. Costs of Machine-Tool Operations in Steam-Engine Manufacturing 729

Workmen—The Compensation of, and Efficiency of Operation (Illustrated) *H. L. Gantt* 17, 161, 331

Wright, Charles L. The Fuel-Briquetting Industry (Illustrated) . 46, 195

EVIEWS, INDEX, AND EDITORIALS.

Accidents in American Metal Mines—Fatal 256
Acid—Sulphuric, from Copper Smelter Fumes 595
Advancer—The Phase, a New Electrical Device 416
Alloys of Copper, Aluminium and Manganese 95
Aluminium, Copper and Manganese—Alloys of 95
American Metal Mines—Fatal Accidents in 256
Application of the Steam Turbine to Locomotives 602
Applications of Electricity—Marine... 749
Aqueduct, the Los Angeles—Power Development on 261
Balloons—Photographic Surveying from 110
Barges—Concrete, on the Panama Canal 586
Blast—Drying, with Calcium Chloride 270
Blindness—Color 115
Blowing Engines, Steel-Works—The Cost of Driving 921
Briquetting Iron and Steel Chips..... 923
British Railway Situation........ 583
Brittleness in Mild Steel........ 274
Buildings, Mill—The Cost of........ 103
Burning, Cement—Combustion in...... 760
Calcium Chloride—Drying Blast with.. 270
Canada, Eastern—The Oil Shales of... 433
Canal, Panama—Concrete Barges on the 586
Cargoes, Ships'—The Weight of...... 265
Castings, Steel—The Electric Furnace for 743
Cement Burning—Combustion in...... 760
Characteristics, Lathe Headstock—A Comparison of 754
Chemical Products—Peat as a Source of 253
Chile—The Nitrate Deposits of........ 112
Chips, Iron and Steel—Briquetting.... 923
Choice of Motors for Machine Tools.. 588
Citizen—The Engineer's Duty as a.... 906
Civil Engineering, Engineering Index 119, 227, 435, 607, 763, 925
Coal Dust—The Electrical Ignition of. 428
Coatings for Structural Steel—Protective 758
Color Blindness 115
Combustion in Cement Burning....... 760
Comparison of Lathe Headstock Characteristics 754
Concrete Barges on the Panama Canal. 586
Condensers, Surface—Water Requirements of 913
Copper, Aluminium and Manganese—Alloys of 95
Copper Smelter Fumes—Sulphuric Acid from 595
Cost of Driving Steel-Works Blowing Engines 921
Cost of Electric Power in New York City 589
Cost of Mill Buildings........ 103
Cutting Properties of Tool Steel...... 751
Deposits—The Nitrate, of Chile....... 112
Design of Furnace Electrodes........ 746
Distillation of Turpentine—The Electrical 108
Driving Steel-Works Blowing Engines—The Cost of........ 921
Drying Blast with Calcium Chloride.. 270
Dust, Coal—The Electrical Ignition of. 428
Duty as a Citizen—The Engineer's.... 906
Eastern Canada—The Oil Shales of... 433
Economizers—Power Plant 739
Economy of the Exhaust Steam Turbine 756
Editorial Comment........ 94, 251, 408, 581, 737, 899
Electrical Device, a New—The Phase Advancer, ... 416
Electrical Distillation of Turpentine.. 108
Electrical Engineering, Engineering Index........ 126, 287, 445, 615, 771, 933
Electrical Ignition of Coal Dust....... 428
Electrical Methods—The Examination of Water by........ 911
Electrical Units—International Standardization of 263
Electricity—Marine Applications of... 749
Electric Furnace for Steel Castings... 743
Electric Lighting for Industrial Plants. 106
Electric Motors for Machine Tools.... 420
Electric Power in New York City—The Cost of........ 589
Electric Spot Welding........ 600
Electric Steel Furnace—The Progress of the 238

Electrification of Railways........... 901
Electrodes, Furnace—The Design of.. 746
Electro-Mechanical Locomotives....... 905
Engineering Index.....................
119, 227, 435, 607, 763, 925
Engineer's Duty as a Citizen.......... 906
Engines, Blowing—The Cost of Driving Steel-Works 921
Examination of Water by Electrical Methods 911
Exhaust Steam Turbine—The Economy of the 755
Fatal Accidents in American Metal Mines 256
Fuel for Open-Hearth Furnaces—Waste Gases as..................... 920
Fumes, Copper Smelter—Sulphuric Acid from 595
Furnace Electrodes—The Design of... 746
Furnaces, Open-Hearth—Waste Gases as Fuel for 920
Furnace, Steel—The Progress of the Electric 258
Furnace—The Electric, for Steel Castings 743
Gases—Waste, as Fuel for Open-Hearth Furnaces 920
Gas Power—Producer, in the United States 418
Gearing for Marine Turbines—Mechanical 272
Graphite as a Lubricant 98
Hardening of Tool Steels............. 423
Headstock Characteristics, Lathe—A Comparison of 754
Homogeneity of Metals............... 426
Hudson Bay Railway................. 117
Hydraulic Turbines—Special and Stock 604
Ignition of Coal Dust—The Electrical. 428
Illumination Requirements in Street Lighting.............................. 917
Index—The Engineering ....
119, 227, 435, 607, 763, 925
Industrial Economy, Engineering Index
132, 292, 451, 621, 777, 938
Industrial Plants—Electric Lighting for 106
Insurance—Labor, in the United States 411
International Standardization of Electrical Units 263
Iron and Steel Chips—Briquetting.... 923
Labor Insurance in the United States.. 411
Lands, Reservoir—The Reforestation of 267
Lathe Headstock Characteristics—A
Lighting for Industrial Plants—Electric 106
Lighting, Street—Illumination Requirements in 917
Lightning Protection—Modern Methods of 592
Locomotives—Electro-Mechanical...... 905
Los Angeles Aqueduct—Power Development on the 261
Lubricant—Graphite as a............. 98
Machine Tools—Electric Motors for... 420
Machine Tools—The Choice of Motors for 588
Manganese—Alloys of Copper, Aluminium and 95
Marine and Naval Engineering, Engineering Index..133, 293, 452, 622, 778, 940
Marine Applications of Electricity..... 749
Marine Turbines—Mechanical Gearing for 272
Mechanical Engineering, Engineering Index.........135, 295, 455, 624, 780, 941
Mechanical Gearing for Marine Turbines 272
Men—The Training of 100
Metal Mines—Fatal Accidents in American 256
Metals—The Homogeneity of 426
Methods of Lightning Protection—Modern 592
Mild Steel—Brittleness in............. 274
Mill Buildings—The Cost of.......... 103
Mines, Metal—Fatal Accidents in American 256
Mining and Metallurgy, Engineering Index.........146, 306, 465, 636, 791, 954
Modern Methods of Lightning Protection 592
Motors for Machine Tools—Electric.. 420
Motors for Machine Tools—The Choice of 588
New Electrical Device—The Phase Advancer, a........................ 416
New York City—The Cost of Electric Power in 589
Nitrate Deposits of Chile 112
Oil Shales of Eastern Canada......... 433
Open-Hearth Furnaces—Waste Gases as Fuel for......................... 920
Panama Canal—Concrete Barges on the 586
Peat as a Source of Chemical Products 253
Phase Advancer, a New Electrical Device 416
Photographic Surveying from Balloons 110

Plants, Industrial—Electric Lighting for 106
Power Development on the Los Angeles Aqueduct 261
Power Plant Economizers 739
Power—Producer Gas, in the United States 418
Power—The Cost of Electric, in New York City 589
Power, Water—The Value of 908
Problems of Refractory Materials 431
Producer Gas Power in the United States 418
Progress of the Electric Steel Furnace. 258
Properties of Tool Steel—The Cutting. 751
Protection, Lightning—Modern Methods of 592
Protection of Piles in Sea Water 414
Protective Coatings for Structural Steel 758
Railway Engineering, Engineering Index 152, 312, 472, 643, 801, 961
Railway Situation—The British 583
Railways—The Electrification of 901
Railway—The Hudson Bay 117
Reforestation of Reservoir Lands 267
Refractory Materials—Problems of 431
Requirements in Street Lighting—Illumination 917
Requirements of Surface Condensers—Water 913
Reservoir Lands—The Reforestation of 267
Science and Industry 597
Sea Water—The Protection of Piles in 414
Shales—The Oil, of Eastern Canada... 433
Ships' Cargoes—The Weight of 265
Smelter Fumes, Copper — Sulphuric Acid from 595
Source of Chemical Products—Peat as a 253
Special and Stock Hydraulic Turbines. 604
Standardization of Electrical Units—International 263
Steam Turbine, Exhaust—The Economy of the 756
Steam Turbine—The Application of the, to Locomotives 602
Steel Castings—The Electric Furnace for 743
Steel Chips, Iron and—Briquetting 923
Steel Furnace, Electric—The Progress of the 258
Steel, Mild—Brittleness in 274
Steel, Structural—Protective Coatings for 758
Steels, Tool—The Hardening of 423
Steel, Tool—The Cutting Properties of 751
Steel-Works Blowing Engines — The Cost of Driving 921
Stock Hydraulic Turbines—Special and 604
Street and Electric Railways, Engineering Index......156, 316, 476, 646, 805, 964
Street Lighting—Illumination Requirements in 917
Structural Steel—Protective Coatings for 758
Sulphuric Acid from Copper Smelter Fumes 595
Surface Condensers — Water Requirements of 913
Surveying from Balloons — Photographic 110
Tools, Machine—Electric Motors for.. 420
Tools, Machine—The Choice of Motors for 588
Tool Steels—The Hardening of 423
Tool Steel—The Cutting Properties of. 751
Training of Men 100
Turbine, Exhaust Steam — The Economy of the 756
Turbines, Hydraulic—Special and Stock 604
Turbines, Marine—Mechanical Gearing for 272
Turbine, Steam—The Application of the, to Locomotives 602
Turpentine—The Electrical Distillation of 108
United States—Labor Insurance in the. 411
United States—Producer Gas Power in the 418
Units, Electrical—International Standardization of 263
Value of Water Power 908
Waste Gases as Fuel for Open-Hearth Furnaces 920
Water Power—The Value of 908
Water Requirements of Surface Condensers 913
Water, Sea—The Protection of Piles in 414
Water—The Examination of, by Electrical Methods 911
Weight of Ships' Cargoes 265
Welding, Spot—Electric 600

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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RAILWAY AND ENGINEERING PROGRESS IN AFRICA.

By J. Hartley Knight.

Mr. Knight's article is a brief but highly suggestive review of engineering achievements and engineering opportunities whose extent is perhaps too little appreciated by many of our readers. And the larger significance is that conveyed by our contributor's concluding sentences: 'that (in Africa) only the fringe of railway development has yet been touched, and for many years to come there will be an increasing and vigorous demand for electrical power and mining machinery and the whole range of mechanical equipment and supplies."—The Editors.

IT was, I think, in 1900 that my first article on railway construction in Africa appeared in these pages, and from time to time since I have been permitted to "report progress" as the iron road continued to advance in that continent, the last occasion being exactly two years since. In the decade thus covered a wonderful transformation has been effected and some notable engineering triumphs remain to be recorded—triumphs which stand as a monument of patience, perseverance, and skill on the part of those who, with splendid strenuousness, have pushed their way into the remotest corners of barbarism and brought the head-light of the locomotive to bear on some of the darkest places of the Dark Continent.

In a railway carriage the other day I heard two men discussing this very subject. One was enthusiastic at the way railway engineering had transformed, and was transforming, Africa; the other was disposed to treat the whole thing slightingly. "See the years they have been at it," he observed; "I can't see what there is to crow about: look what has been done in America since *they* first started to build railways and compare it with the total mileage of work actually accomplished in Africa! Why, there's simply no comparison!" Possibly not; but it apparently did not occur to the speaker that the conditions on the continents are not quite the same and that to institute comparisons was not only absurd but also grossly unfair, seeing that

THE RAILWAY STATION, CAIRO.

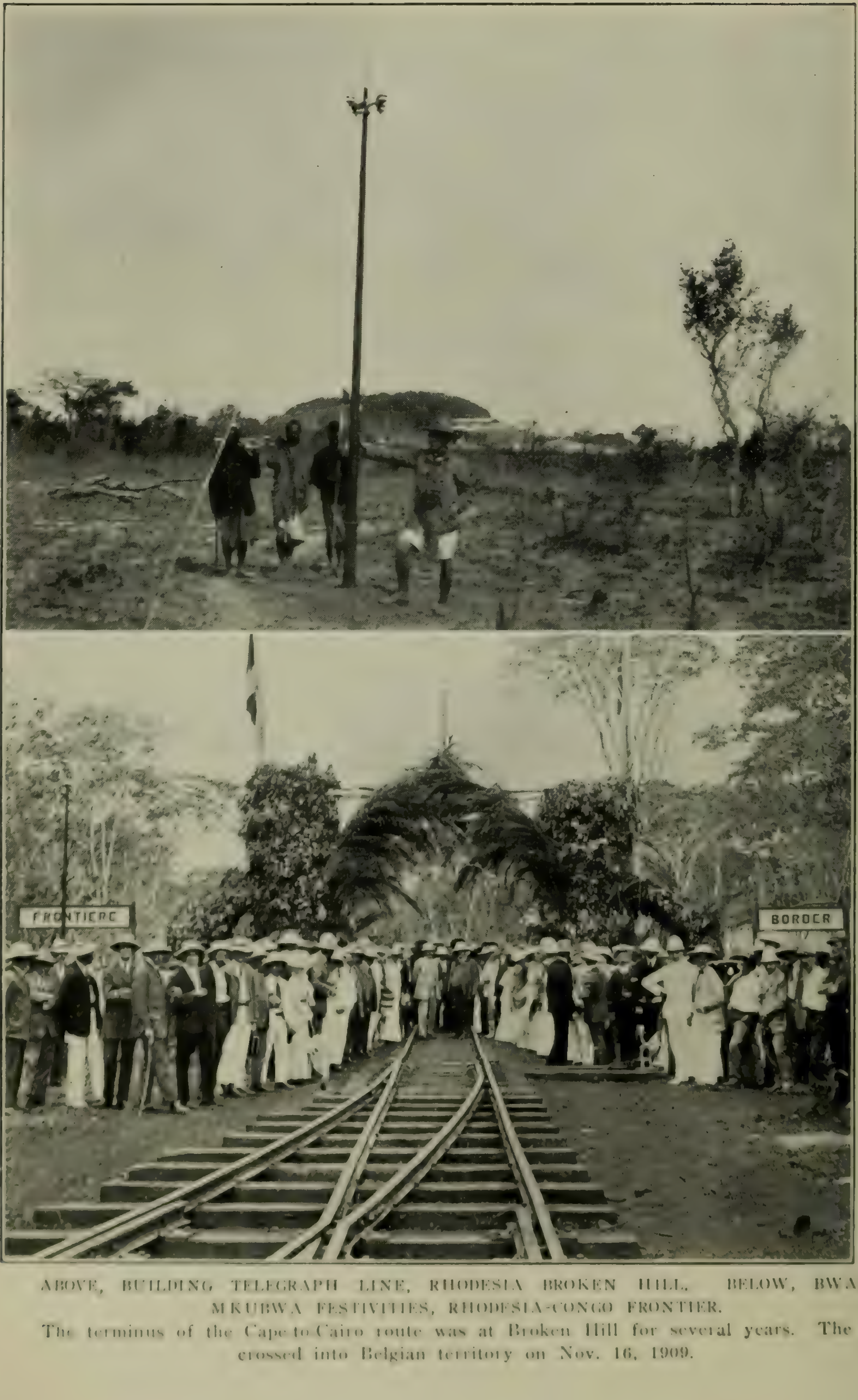
THE RAILWAY STATION, CAPE TOWN.

These two stations are the termini of the gigantic and by some thought chimerical project of a through north and south line across Africa, which Mr. Knight says is now in not the smallest doubt of early completion.

the white population of Africa all told is not to be mentioned in the same breath with that of America, to say nothing of the former's political divisions and the consequent want of co-ordination in dealing with railway affairs.

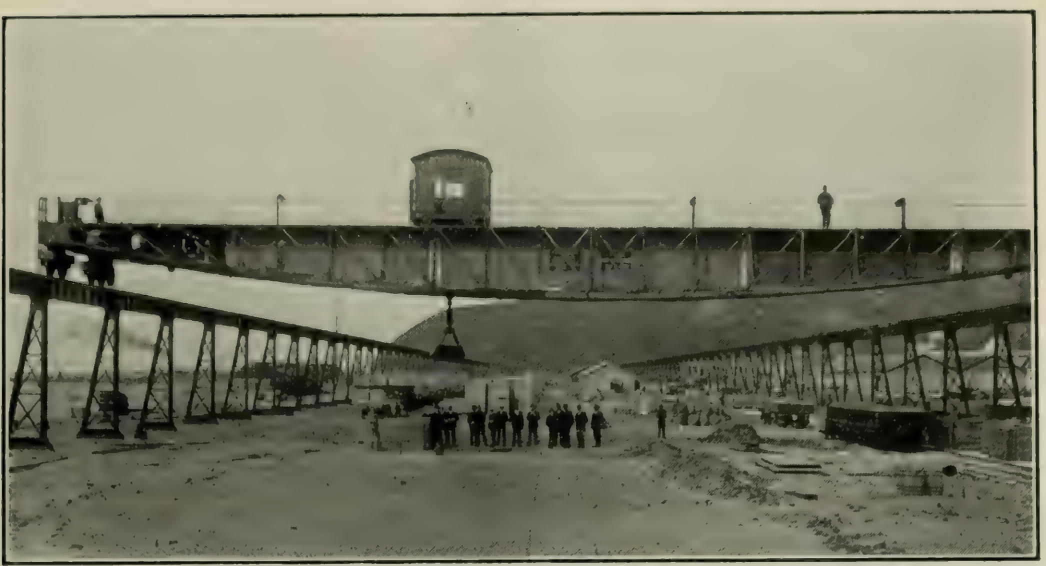
INTERIOR OF DURBAN STATION, NATAL GOVERNMENT RAILWAYS.

The fact remains that the white peoples of Africa, sparse and scattered as they are, have much to be proud of in the matter of railway development, and especially so in the sub-continent. But when all is said and done the line known as the Cape-to-Cairo Railway—popularly supposed to be the conception of the late Cecil Rhodes—is still the most fascinating and most "fancied" of all the lines in Africa. The object of that railway is not, as Rhodes himself once pointed out, to enable a human being to get in at Cape Town and get out at Cairo. Rather is it "to cut Africa through the centre," so that the railway "will pick up trade all along the route. The junctions to the east and west coasts, which will occur in the future, will be outlets for the traffic obtained along the routes of the line as it passes through the centre of Africa." And slowly, but none the less surely, that cutting process is still going on, to the chagrin of those who predicted a dismal failure of the whole scheme after Rhodes's death, and the astonishment of the croakers who stigmatised the idea as chimerical almost from its very conception.



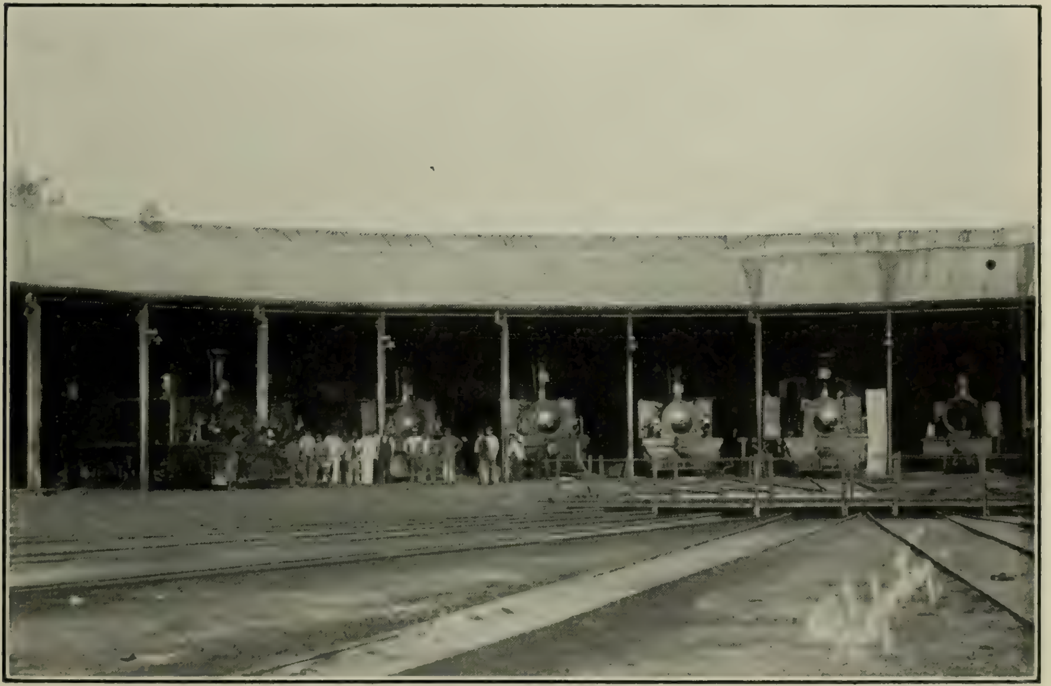
ABOVE, BUILDING TELEGRAPH LINE, RHODESIA BROKEN HILL. BELOW, BWANA-MKUBWA FESTIVITIES, RHODESIA-CONGO FRONTIER.

The terminus of the Cape-to-Cairo route was at Broken Hill for several years. The line crossed into Belgian territory on Nov. 16, 1909.



ELECTRIC GANTRY CRANE, 105-FEET SPAN, PORT NATAL.

What is the position of the railway today? Nearly two-thirds of the whole line, from Cape Town in the south to the Congo border, and from Cairo in the north to a point nearly 200 miles south of Khartoum, are practically completed; and there is now not the smallest doubt that the intervening stretch will "get itself built" in due course. If the original idea of the route from the south is not being strictly adhered to, it does not matter a solitary dime, so long as the line advances. And this it is doing in spite of local difficulties, engi-



ROUND HOUSE, LOURENÇO MARQUES.

neering, international, or financial. When I "left" the line, a couple of years since in these pages, railhead was at Rhodesia Broken Hill, and there it remained for several years. In January last, however, a contract was entered into with Messrs. Pauling, the railway engineers, for an extension of the line to Bwana Mkubwa, on the Congo border, some 132 miles away, which point was reached on November 16 last.

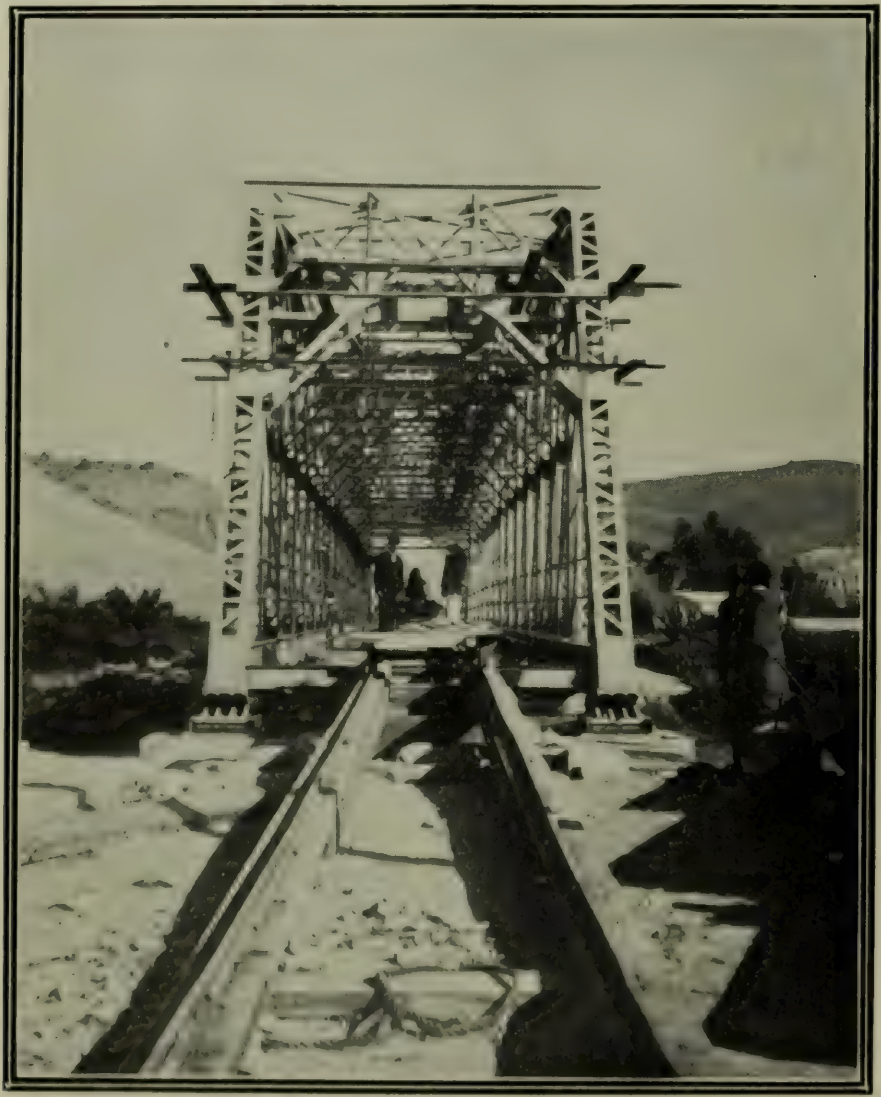
TRAIN DE LUXE, RHODESIA RAILWAYS.

BENGUELLA: THE STARTING PLACE OF THE RAILWAY.

The same engineers are now busy on the other side of the border and expect to reach the next stage of the work—the Star of the Congo mine—early in October. Two bridges and two embankments are included in the recently completed section, the line running for miles through forests of native teak wood.

Early in December, Bwana Mkubwa was the scene of an interesting gathering of railway men and others, who assembled by special invitation to celebrate the passage of the first train across the Belgian frontier. Under a triumphal arch, gaily decorated with flags and situate in the heart of a forest, the last two fishplates (made of locally-smelted copper) were riveted on either rail by two of the leading men present, namely, Mr. Wallace, the Administrator of Northwestern Rhodesia, and Baron Wangerwee, the representative of the Congo. A few minutes later the special engine and train steamed across the border and pulled up into Belgian territory. At the banquet which followed, some interesting speeches were made, not the least so, being delivered by Mr. T. S. McEwen, general manager of the Cape Government Railways, who incidentally contrasted South African railways with the other systems of the world, maintaining that for comfort and catering they were equal to British railways, and only slightly, if at all, inferior to American.

As has been indicated, the intention is to carry the line to the highly-mineralised region known as the Star of the Congo, and probably thence onwards to a point near Kambove. Ultimately, it will meet the Benguella railway now advancing from Lobito Bay, in Portuguese West Africa, some details of which will be found in my article of two years ago. The most difficult part of the work, from Lobito Bay up to kilometre 216, was constructed by Griffiths & Co., Contractors, Ltd., and included a rock section and numerous bridges and other heavy work. The contract having been completed, the work was put up for re-tender and the offer of Messrs. Pauling was accepted and the work is now being proceeded with. From Lobito Bay to the line's objective in the Katanga district is roughly about 900 miles, almost in a straight line, but the extension from kilometre 216 should be child's play to the engineer, seeing that the country between it and Katanga—so Mr. Norton Griffiths once told me—is as flat as a billiard table and presents no engineering difficulites.

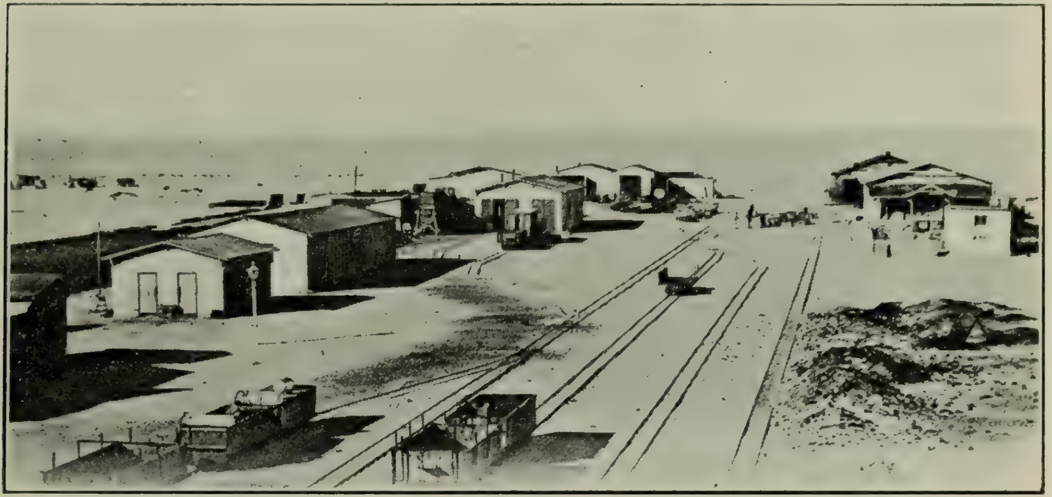


CATUMBELLA BRIDGE, LOBITO BAY RAILWAY, PORTUGUESE WEST AFRICA.

Of course, the idea is to make the Benguella line pay its way section by section. "Once we reach kilometre 320," wrote an official of the company, "the earnings from the railway will be sufficient to pay the expenditure and leave enough for the debenture interest." Mr. Robert Williams, the moving spirit in the Lobito Bay-Katanga scheme

—has recently arranged with the Portuguese Government for favorable modifications in the original concessions whereby an extension of time has been given to build further sections of the line.

From what point or when the Cape-to-Cairo line will be extended northwards no man at the moment knoweth. Two years ago, I predicted that the other prong of the contemplated fork from Broken Hill to the north—that running through German territory alongside Lake Tanganyika—would be abandoned "for some years to come, at all events." Today, it looks as if that route is abandoned for all time. I do not say the Germans are to blame for that; but I do say that they have never shown any particular enthusiasm for the Cape-to-Cairo scheme. Possibly, they think that with such a splendid waterway on hand there is no need to build a line alongside it in their territory, but that the Cape-Cairo railway should connect north and south with the lake. I certainly think that in time to come we shall see a line running from Broken Hill to the most southerly corner of Tanganyika, there to connect with a fleet of lake steamers, but at present there is no intention to carry the railway in that direction. The present tendency, as I have shown, is to carry it westwards, and the chances are that in time to come it will be united with the system known as the Great Lakes Railway, and thence be carried across country till it reaches Uganda or some point in Southern Sudan where it can be linked up with Khartoum and so carried on to Cairo.

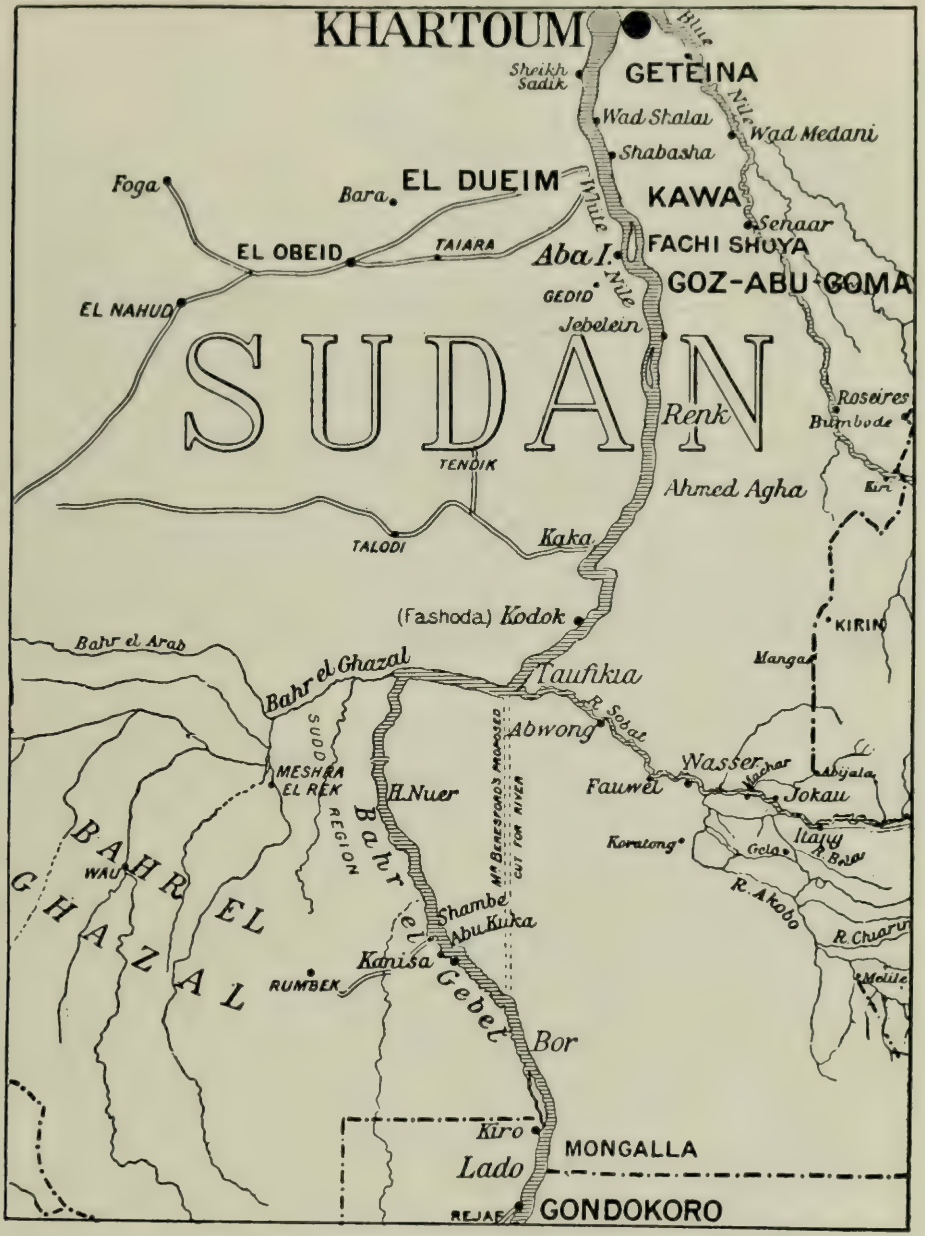


SWAKOPMUND, GERMAN SOUTHWEST AFRICA.

Meanwhile, the railway is rapidly being pushed on south of Khartoum, a section of 120 miles, as far as Wad Medani—an important place on the Blue Nile—having been opened for traffic. Construction is still going on, at the rate, I understand, of a mile a day, the course

IN THE MABIRA FOREST, UGANDA.

of the line continuing some 50 miles further south along the Blue Nile and then turning westward across the Ghezireh to the White Nile at Kosti, where a fine new bridge is nearing completion to take it up to El Obeid in the Kordofan district. The section from Kosti to El Obeid will not, however, be on the Cape-to-Cairo route and through travellers will have to leave the rail at Kosti for the south by boat up the White Nile. In addition to the Blue Nile railway bridge another is in course of construction over the White Nile at Goz-Abu-Gowa, 192 miles south of Khartoum. Both these bridges are being built, I understand, by the Cleveland Bridge Co., of Darlington, England, the firm responsible for the great bridge spanning the gorge of the Victoria Falls, in Rhodesia.



SKETCH MAP OF THE SOUTHERN SUDAN.

I have referred to Uganda, which is likely to play a not unimportant part in the distant development of the Cape-to-Cairo scheme. Up to the present, however, Uganda itself is innocent of railways—the well-known line which bears its name being, of course, in the adjacent territory of British East Africa—unless one can call three miles of mono-rail, which is now being experimented upon, near Kampala, a railway. Schemes are projected for the construction of a

OBUASSI STATION, BRITISH WEST AFRICA.

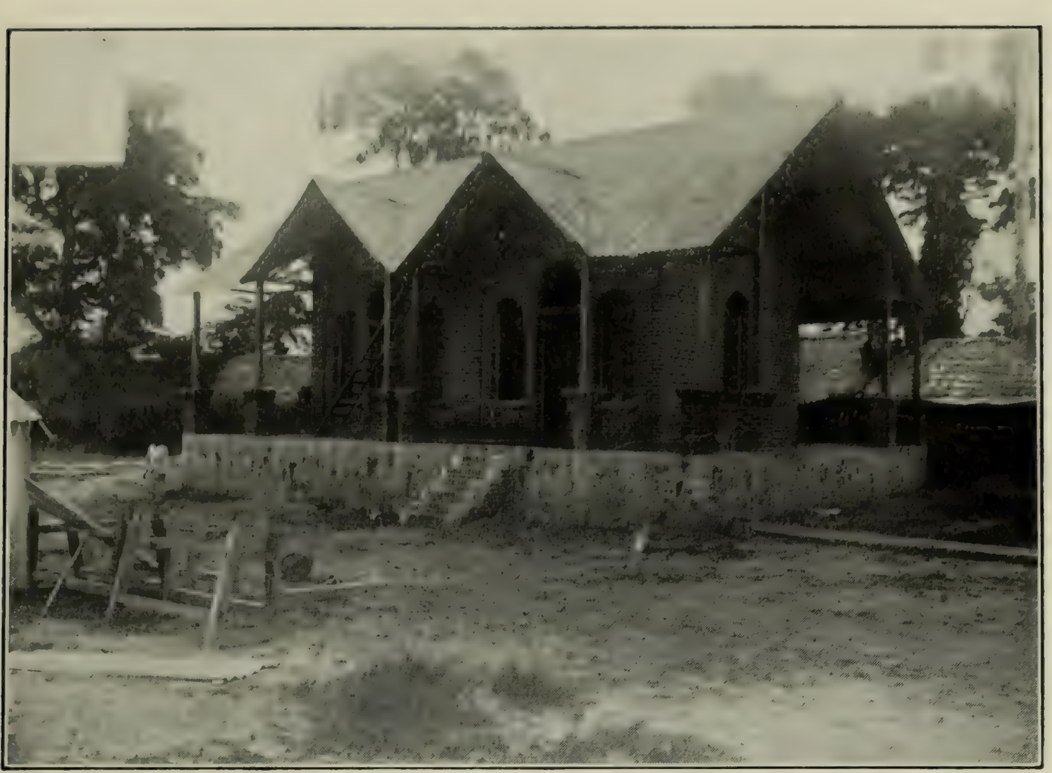
line in Uganda which will probably be worked as part of the Uganda railway or in conjunction with it. Another proposed line is intended to go from Kampala to the Congo border, and—who knows?—perhaps this is destined to be the connecting link of the trunk line the southern railhead of which is, for the time being, at Bwana Mkubwa.

Of the Uganda Railway, so-called, but little need be added to what I have said about it in previous articles. It has reached the paying stage, even if the returns for the year ended March 31, 1909, showed but a very slight improvement over the preceding twelve months. Extensions from the main line are either in being or are contemplated, and in the latter category may be placed the line which is to open up the great natural soda deposit known as Lake Magadi. This branch is to be constructed and worked by the Government, and will be of the same pattern as the Uganda Railway, of which it will form a part. The route was lately surveyed by Mr. Fred. Shelford, the well-known engineer, and the country traversed proved to be extremely difficult, the route being continually crossed by escarpments, eight to ten miles long, and 300 to 400 feet high. Lions were constantly met with en route and at one camp an infuriated rhino deliberately charged a tank containing the only supply of water.

On the other side of the continent both in British and French territory, a good deal of activity in railway circles has to be chronicled. Two years ago in The Engineering Magazine I gave some account of what the British proposed to do in opening up Nigeria and how a line of 3 feet 6 inches gauge and 400 miles in length was to connect Baro on the River Niger, with Zangera and Kano, and, ultimately, Kano with the coast port of Lagos. Excellent progress has been made with the two sections of the line and it is expected that by September next through communication will be established between Lagos and Kano. The section from Lagos to Jebba was completed in April last. Opposite to Jebba the River Niger flows in two branches enclosing a small island, and eventually the river will be crossed at this point by two large bridges. To the north of this the line is being continued to the Kaduna river and thence along the course of a steam tramway—built by the former High Commissioner, Sir F. Lagard—to Zangera. From Zangera a connection will be established with the Baro-Kano line and thus on the completion of the latter section (possibly during the coming year) one will be able to travel from Kano

OROUGOO BRIDGE NEAR FREETOWN, SIERRA LEONE.

ABOVE, A TYPICAL LOW VELDT STATION IN THE TRANSVAAL. BELOW, ON THE LINE OF THE SWAZIELAND RAILWAY.



DWELLING HOUSE UNDER CONSTRUCTION AT STANLEYVILLE, CONGO FREE STATE.

ONE OF THE BRIDGES ON THE STANLEYVILLE RAILWAY, UNDER CONSTRUCTION.
These are features of the Great Lakes Railway project.

ON THE NILE.

either all the way by train to the coast at Lagos, or by train to Baro and thence by river steamer to the mouth of the Niger.

Elsewhere, other lines are being constructed which, although perhaps of a minor character, are yet of considerable local importance and have a direct bearing on the African railway scheme as a whole. This article has already run to such length that I can only give these barest mention. Thus, in the sub-continent, the much-needed line which is to connect Cape Colony and Natal is at last nearing completion, and in the latter colony there is an accumulation of railway work to be carried through, including the line into Zululand. Several new lines are to be built in Orange River Colony, one of which will open up a new route to Basutoland and tap some very rich farming country. Some notable extensions are in progress in the Transvaal; and in Rhodesia a start is to be made this year with the first section of the line between Majol and Abercorn. It remains to be seen what effect the forthcoming Union of South Africa will have on local railway projects.

In German, French and Portuguese Africa many important projects are contemplated, not the least of these being that between Inhambane and Inharrime, in Portugal's south-east territory. Railway activity is also reported in the vicinity of the Great Lakes Railway, in the Congo region; and in Egypt the railway engineers are busy in more than one direction. In no other part of the world, perhaps, is railway construction so much to the fore as in Africa, and the amount of material now being poured into that country from all parts of the world must be enormous. And the glad fact, from the engineering point of view, remains that only the fringe of railway development has yet been touched, and that for many years to come there will be an increasing and vigorous demand for electrical power and mining machinery and the whole range of mechanical equipment and supplies.

COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION.

By H. L. Gantt.

III. TASK AND BONUS.

Mr. Gantt's series, which is attracting widespread and close attention from employers and managers of labor, began in our issue for February last. Preceding parts have considered the efficiency of workers as influenced by mode of management and compensation under the day-work and piece-work systems, respectively. The fourth part, which will follow in May, will show in detail, by the aid of most interesting colored charts, what has been accomplished by Mr. Gantt's system in various occupations and in a large number of individual cases.—The Editors.

IN the previous articles an attempt was made to show that present labor conditions—that is, labor unions and employers' associations—are a natural and almost a necessary result of the present methods of handling workmen. The horizontal wage, under which men in a certain class get a certain wage and under which it is practically impossible for any individual to get much more than the average day, or piece-work, wage of the class, has its effect in causing the workmen of that class to combine to get the average wage of the class increased.

It was also explained that as long as we classified workmen and paid those of one class substantially one wage, without greatly varying that wage according to efficiency, the efficient men, realizing that they could not get any more money than was paid to the average of their class, would continue to combine with the others in that class to have the class wage raised. This is what they have done in the past; and, if we read human nature aright, this is what they will do in the future, until some means has been devised by which the efficient man can get proper compensation for his work. When his compensation is independent of what the inefficient man gets, he will not worry himself greatly about combining with the inefficient man. The employer recognizes that the efficient man is worth more to him than the inefficient man, but most employers do not know any scheme by which they can compensate the efficient man according to his deserts, and avoid trouble with the inefficient man.

The object of this article is to show what we have accomplished both in the way of rewarding the efficient man, and of making the inefficient man efficient.

In 1899 I was offered a position with the Bethlehem Steel Company to assist in putting into operation methods for increasing the efficiency of their labor. This work was being done by Mr. F. W. Taylor, with whom I had been associated twelve years previously in the Midvale Steel Company, where the methods underlying Mr. Taylor's work had originated, and where they are still in operation.

One object that Mr. Taylor had in mind was to establish throughout the plant a system of piece work based on a scientific study of what could be done, and to make piece rates that should be permanent. The portion of the works that seemed to offer the greatest field was the main machine shop; but before setting these piece rates it was necessary to make a great many changes. Machines in this shop had been located, not with reference to any particular system of management (because nobody had given the system of management any particular thought) but promiscuously, throughout the shop.

In order to do work economically it was desirable to rearrange the machine tools in such a manner that a foreman, expert on one class of work, should be able to supervise that work. Accordingly the location of the machines was so changed as to place the large lathes in one group, the small lathes in another, the planers in another, etc. While the machines were being moved they were respeeded to enable them to utilize to advantage the improvements that had been made in tool steel, Mr. Taylor at the same time making a large number of experiments[*] to determine the best shapes of tools and the best tool steel with which to do the work, which in this shop was very miscellaneous in character. Even when we got the shop rearranged, much study still had to be done before we could know enough about the conditions to make permanent piece rates.

The high degree of perfection demanded by Mr. Taylor took much time; and the consequence was, that although slide rules for determining how to do machine work and instruction cards for directing the workmen had been in use since May, 1899, the monthly output of the shop during the year from March 1, 1900, to March 1, 1901, had been but little more than the monthly average for the five years preceding.

Up to this time we had devoted ourselves to the study of what could be done, and had done but little to cause the workmen to co-operate with us. This record shows that we had not in any measurable degree secured their co-operation. In other words, we had much knowledge, but were unable to get any substantial benefit from it because the men would not help. Not being ready to introduce the differential piece-rate system, which was regarded as the ideal one for obtaining a maximum output, I felt that we should not wait for perfection, but should offer the workmen additional pay in some manner that would not interfere with the ultimate adoption of the differential* piece-rate system. Accordingly on March 11, 1900, I suggested that we pay a bonus of 50 cents to each workman who did in any day all the work called for on his instruction cards. This was adopted at once, and Mr. E. P. Earle, the superintendent of the machine shop, suggested that we should also pay the gang boss (man who supplied the work) or speed boss (foreman) a bonus each day for each of his men that earned his bonus. This was also approved, and both plans were ordered to be put into execution as promptly as possible.

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[*] The result of these experiments was the development of the Taylor-White method of treating tool steel.

This bonus payment was begun at once, and on May 13 the assistant superintendent of the machine shop, Mr. R. J. Snyder, made the following report:

Mr. E. P. Earle,
Supt. of Machine Shop No. 2.

Dear Sir:

I hand you herewith some notes on the results obtained by the introduction of the "bonus" plan for remunerating labor in No. 2 machine shop. (Here follow machine numbers and dates when they were started on this plan.)

One of the best results after a short trial has been the moral effect upon the men. They have had it placed in their power to earn a very substantial increase in wages by a corresponding increase in their productive capacity, and this has given them the feeling that the company is quite willing to reward the increased effort. They display a willingness to work right up to their capacity, with the knowledge that they are not given impossibilities to perform. This effect has been brought about by the good use of our excellent slide rules in the hands of a number of the most thoroughly practical men, who, when the results which they demand have been declared impossible to obtain, have repeatedly gone out into the shop and themselves demonstrated that the time was ample, by doing the work well within the limits set. All this has inspired the confidence of the shop hands, and the excellent instruction cards sent out are gradually evolving from laborers a most efficient lot of machine hands. . . . The percentage of errors in machining has been very materially reduced, which is unquestionably due to the fact that in order to earn his bonus a man must utilize his brains and faculties to the fullest extent, and so has his attention closely fixed on the work before him, as every move must be made to count. He thus has no time for dreaming, which was, no doubt, the cause of many errors.

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*The differential piece rate was devised by Mr. F. W. Taylor while with the Midvale Steel Co. to stimulate maximum production. It consisted of a high rate per piece if a definite large product per day was attained, and a lower piece price if the output was less than the amount set. The effect of the system was to cause a big increase in wages for attaining a definite degree of efficiency.

The condition of the machines is vastly improved. Most care has been taken to point out to the men that the best results can be obtained only by keeping their machines in good running condition, well lubricated and cleaned. They have not been slow to realize this, and cases of journals cutting fast are very rare, while before the introduction of the "bonus" plan this was a very common occurrence. Breakdowns are also of a less frequent occurrence.

The crane service lately has given us little trouble, and lack of crane service was formerly a constant excuse of the bosses and men for not being able to keep machines filled with work. The improvement in this case arose from the rule laid down that no exceptions or allowances would be made for delays due to this cause.

It is only by the introduction of this "bonus" plan that we have had furnished the automatic incentive for men to work up to their capacity and to obtain from the machines the product which they are capable of turning out. It has lifted the hands of the speed bosses (foremen) and enabled them to act in the capacity for which those positions were created —that of instructors.

These are some of the direct results obtained. Indirectly it has eliminated the constant necessity for driving the men, and has enabled the shop management to divert some of its energy into perfecting the organization, which only will enable us to give a good account of the shop equipment. Much good has also resulted from putting the work through in lots, and keeping each machine as nearly as possible on the same kind of work.

It is also a pleasure to note in this connection the deep interest taken in the work by the men connected with it, and the fine co-operative spirit which prevails among all hands.

This report was made only two months after the bonus system was started, now nearly nine years ago, and is particularly valuable as it emphasizes some of the fundamental principles on which successful work of this character must be founded. We must secure the confidence and co-operation of the workman by assuring him equitable compensation. If we fail to do this, any results we may get will be of short duration and our work will finally come to naught. Many of the failures to get continuously the high efficiency which seemed easily possible, have been due to a disregard of the fact that the workman is entitled to a share in the benefits of increased efficiency, and in the long run will not co-operate unless he gets it.

The attempt to drive the workman to increased efforts which benefit the employer alone, necessarily creates a force of opposition which grows greater as it is carried farther. Finally, the force of opposition becomes so great that further progress is impossible and the system of management based on *force* breaks down. This is as it should be, if we are to progress from an era of force to one of equity, and to make obsolete the doctrine that "they should take who have the power and they should keep who can." Continual failure to obtain our ends permanently by force, and success in obtaining them by co-operation, will ultimately show that the selfishness that prompts the use of force is unintelligent, and that the most intelligent selfishness is that which shares the benefits equitably among those helping to obtain them.

In closing the discussion on a paper on training workmen, read before the American Society of Mechanical Engineers, December, 1908, I made the following statement:

> A system of management may be defined as a means of causing men to co-operate with each other for a common end. If this co-operation is maintained by force, the system is in a state of unstable equilibrium, and will go to pieces if the strong hand is removed. Co-operation in which the bond is mutual interest in the success of work done by intelligent and honest methods produces a state of equilibrium which is stable and needs no outside support.

In the paper itself the following statements are found:

> The general policy of the past has been to drive, but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned.
>
> It is too much to hope, however, that the methods about to be described will be adopted extensively in the near future; for the great majority of managers, whose success is based mainly on their personal ability, will hesitate before adopting what seems to them the slower and less forceful policy of studying problems and training workmen; but should they do so they will have absolutely no desire to return to their former methods.

In some quarters I have been regarded as not making the most of opportunities because of adherence to this policy, but results in the long run have been so much greater and more stable than those obtained by the driving method, that even the strongest advocates of force are beginning to recognize that in their desire *to get great results quickly they may fail to get them permanently*.

To go back, however, to the Bethlehem Steel Works, we note that the average monthly output of the shop from March 1, 1900, to March 1, 1901, was 1,173,000 pounds; and from March 1, 1901, to August 1, 1901, it was 2,069,000 pounds. The shop had 700 men in it and we were paying only about 80 men on the bonus plan out of that 700. I left the employ of the company in September, 1901, but the number of bonus workers increased for some time, although an unintelligent selfishness on the part of the management soon caused them to cease paying any bonus to the foreman. Other changes gradually followed, until in a few years the essential principles of this work were practically eliminated and the efficiency of the shop ran down to such an extent as to become notorious. A complete return to the *drive method* after repudiating these principles, has produced a series of labor troubles, which, at this writing, have culminated in closing down the whole plant.

Contrast this with over thirty years' freedom from labor troubles enjoyed by the Midvale Steel Company, where long ago these methods had their beginning.

The plan as started at Bethlehem of paying a fixed bonus for performing the task had one element of weakness, namely, that after the men had earned their bonus there was no further incentive to them. It was some time before I devised a satisfactory method for adding such an incentive, which was finally accomplished by paying the workman for the time allowed *plus a percentage of that time.*

For instance, if the time allowed for a task is three hours, the workman who performs it in three hours or less is given four hours' pay. He thus has an incentive to do as much work as possible. If the workman fails to perform the task within the time limit he gets his day rate. The time allowed plus the bonus is the equivalent of a piece-rate; hence we have piece work for the skilled and day work for the unskilled.

One other feature of this work at Bethlehem had a most important effect on the result—namely, that in addition to the bonus paid the foreman for each man under him who made bonus, a further bonus was paid if *all* made bonus. For instance, a foreman having ten men under him would get 10 cents each, or 90 cents total, if nine of his men made bonus; but 15 cents each, or $1.50 total, if all ten made bonus. The additional 60 cents for bringing the inferior workmen up to the standard made him devote his energies to those of his men who most needed them.

This is the first recorded attempt to make it to the financial interest of the foreman to teach the individual worker, and the importance of it cannot be over-estimated, for it changes the foreman from a driver of his men to their friend and helper.

Under former conditions, the foreman hesitated to teach the workman for fear the latter might learn as much as he knew and possibly get his job. Under the new conditions, the man who knows is paid for teaching others as much as he knows, and the others are paid a bonus for learing and doing what they are taught. It is this feature of the task and bonus system that has enabled us not only to obtain, but to maintain permanently, such satisfactory results. The expert workman who becomes a good teacher soon makes his services valuable, for, by his assistance, *we can often make the average efficiency of the shop even greater than his best efficiency was before we began to study the question of efficiency. He learns to remove obstacles which stood in his way when he was a simple workman, and often becomes an expert also not only at removing these obstacles, but of developing better methods to avoid them.*

Such, in brief, is the history of the development of the task and bonus system, which, starting as a substitute for differential piece work, gradually supplanted it, differing only by the fact that the worker who failed to earn the high rate got his day's pay instead of a lower piece rate, thus allowing the inefficient workman a chance to earn a living while learning to become efficient. This effort to help the poor workman by giving him a living wage and an instructor, enables us to utilize many bright young men who either did not have a chance to learn a trade, or did not appreciate it when they had it. This is an exceedingly large class, and one that we find everywhere.

To review again the elements on which this system is founded, we note:

1.—A scientific investigation in detail of each piece of work, and the determination of the best method and the shortest time in which the work can be done.

2.—A teacher capable of teaching the best method and shortest time.

3.—Reward for both teacher and pupil when the latter is successful.

Are not these elements sure to make for success? The fact that we have been able to develop promptly workmen who could satisfactorily perform any ordinary task is the best answer. This method of providing workers for the semi-skilled jobs of a factory has been so successful that we are led to ask whether our method is not the basis on which to found a system of instruction and training for apprentices and workmen in general.

In the next article we shall show in detail what has been accomplished, and give data which prove that money invested in establishing a scheme of management and training on these lines yields a very large return.

One of the best results of this work is that the trained workmen almost always hold on to their jobs, and the few that leave soon come back. This will be most clearly demonstrated in our next article, in which it will be shown that under our methods workmen take pride in being efficient.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

In the series of which this is the first part, Mr. Koester's purpose is not to instruct the specialist in hydro-electric engineering. It is to provide a clear and concise statement of the fundamentals of established practice in this field for the use of others who may be interested, either as practitioners in other provinces of engineering, as owners or managers of power-using installations that may be electrically operated, as providers or purchasers of machinery for some part of the equipment, or as commercial or financial participants in some development involving the utilization of water power.—The Editors.

PRACTICALLY all civilized countries today lay great stress on the utilization of their water-powers, and especially during the past few years various governments have taken more or less active interest in securing equal benefits to all from such natural resources. What only a few years ago by many was deemed of little importance, is today one of the greatest problems with which the engineering profession has to cope.

The latest government reports show that the total development in the United States represents 5,356,680 horse power, the number of wheels being 52,827, or an average development per wheel of about 100 horse power. The State of New York possesses the largest water-power development, the total being 885,862 horse power. It is only proper to state that the Niagara powers on the American side assist in making up this large total. The State ranking second in these developments is California, the total being 466,774 horse power distributed among 1,070 wheels, or an average installation per unit of 436 horse power. The third in rank is Maine with a total development of 343,096 horse power, generated by 2,797 wheels, averaging 123 horse power.

The reports show further that the total available power of the surveyed portions, including storage possibilities, is about 53,000,000 horse power, and as only about one-fourth the total area of the United States is now surveyed, the available power for the whole United States may reach at least 200,000,000 horse power and probably more.

The following table enumerates the water powers that can be developed in eight European countries on the basis of quantities of water per second available during nine months, according to the latest reports:

	Total H. P.	H. P. per Sq. Km.	H. P. per 1000 Inhabitants.
Great Britain	963,000	3.06	23.1
Germany	1,425,900	2.6	24.5
Switzerland	1,500,000	36.6	454.5
Italy	5,500,000	19.0	169.
France	5,857,000	10.9	150.
Austro-Hungary	6,460,000	9.6	138.
Sweden	6,750,000	15.0	1290.
Norway	7,500,000	20.0	3409.

NOTE: One square kilometre equals 0.386 square miles.

Switzerland has the largest water power available per square kilometre, but Norway has by far the largest available water-power per 1,000 inhabitants, and has 5.36 times the available power possessed by Germany. On the other hand, the present commercial value of water power of Germany is by no means in the same ratio to the water powers of Norway, because Germany will be able to find use for all its available water power in the near future while Norway, at present, could utilize only about 10 per cent of its available power.

However, close observation of all facts pertaining to water power developed would indicate that the countries which are foremost in hydroelectric development are the United States, Canada, Switzerland, Italy, Sweden and Norway. The next group of countries, in which the water power resources are more limited, covers France, Germany, Austria, and Great Britain. In the next group we may put those countries which have great water-power resources but comparatively few developments, being Mexico, South America, Australia, Japan, and South Africa. The fourth group embraces such countries as have done very little in the development of these natural resources, viz., Russia, Spain, Greece and India.

America is the land of unlimited possibilities and rich in natural resources of all kinds, including water power, and as American engineers always strive to produce engineering work on a record-breaking scale, the United States naturally leads all countries in large water-power developments. Great financial resources being at hand, it is possible to secure great results in a very limited space of time; and this is done in order to place the proposition on a paying basis as quickly as possible, and frequently regardless of real economy. The sacrifice is due to the fact that the engineer does not take the time to ponder over the many small details through which the economical operation of a plant is secured and interruption of service are prevented. In fact, it is quite common practice to overhaul and improve such plants after a few years in order to place them on an economical operating basis, particularly when forced by competition. Our hydroelectric developments are often examples of our national wastefulness.

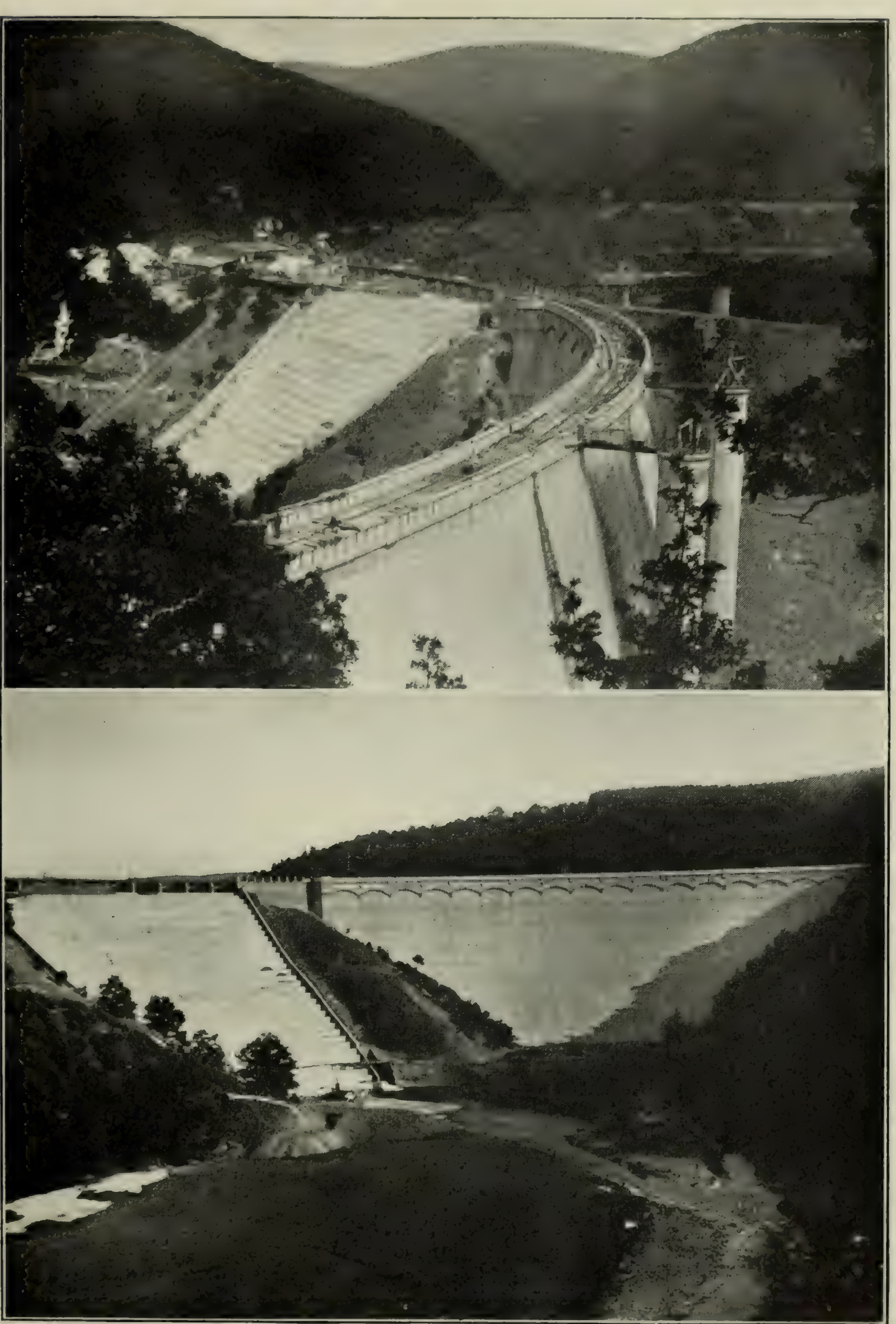
In contradiction to this practice, that of Continental Europe, limited in its water-power and financial resources, is to give such engineering undertakings a thorough preliminary study and to pay careful consideration to the many details upon which refinement in economy and reliability of operation depend. This applies not only to the transformation of water power into electrical energy, but also to the transmission and distribution of current, and we find here also that American engineers are boldest in their undertakings.

If we wish to find originality of scheme and novelty in design, we must generally look elsewhere; and in the following treatise an effort is made to discuss the latest American and European practice, from the viewpoint of a broad and extended experience both in the United States and in Europe.

In connection with the development of water powers much preliminary study is necessary, as to drainage area, the advantageous location of plant, and especially the market for current, upon which depends the commercial success of the undertaking. Reliable data must be collected in order to put the proposition in definite form to submit to the capitalists. Although the public, year after year, is made more familiar with the financial worth of hydroelectric developments, it is one of the most difficult of propositions for the engineer or promoter to arouse public interest, and particularly the interest of the capitalist, in undertakings of this kind.

In the "harnessing" of water in connection with hydroelectric developments, we may recognize two systems, that of impounding the river, and that of deflecting the flow of the river. Developments of the former kind were formerly used principally for irrigation, navigation, protection against floods and city water-supply purposes. In recent years, however, this system has also been adopted for power purposes and we find, particularly on the continent of Europe, two or more of the above propositions are simultaneously carried out as one scheme which offers the most economical plan for the utilization of water. That such a combination requires many-sided and far-sighted preliminary study is without question. The utilization of mountain lakes bears a relation to this system, requiring, however, no artificial dam, as the water is already retained in the collecting basin without impounding; the lake is either tapped at the bottom, or, according to new Swiss practice, the water as needed is siphoned out.

The other system is that in which the flow of water is deflected by a dam built either across the river, or at an angle and partly across it.



TWO VIEWS OF THE URFTTALSPERRE DAM, A TYPICAL CONTINENTAL STRUCTURE.

Whatever system may be employed, the forests of the drainage area bear a most important relation to the successful development. It is a well-known fact that the soil of forests retains the water of

DAM OF THE UTICA GAS AND ELECTRIC COMPANY, TRENTON FALLS, N. Y.

precipitation uniformly and releases it gradually so that a supply of water is assured during the dry season. Flat land without trees may hold the water in swamps, but in most cases it is drained away rapidly, so that streams having denuded watersheds are subject to either floods or droughts. Observations prove that forests receive a greater precipitation than bare lands in the same vicinity, and also that mountainous land, whether bare or covered with forests, receives more precipitation than flat country at the same altitude. Furthermore, the factor of evaporation in forest lands is 25 per cent less than for bare land. The advantage of forests in connection with hydroelectric developments may be best seen from the observations made in Switzerland, showing that before the destruction of certain forests a flood occurred at an average period of 54 months, whereas after the destruction the flood period averaged 29 months.

In the majority of cases reports on the drainage areas covering precipitation, flow, etc., may be had from the government reports. They should not, however, be accepted without reserve, but investigation should be made on the spot to confirm the reports and to secure further data. The method of measuring the flow by means of the miner's inch as originally and extensively carried on in California is now obsolete. The use of the weir dam may be satisfactory for a small flow, but when the flow of large rivers is to be measured modern and more scientific methods must be adopted, such as the current meter. It is necessary to establish observation stations on the main stream and its tributaries. The records of levels must cover a period of several years, readings being made every day and twice per day or oftener during flood seasons in order to establish fair average results.

These results must be properly plotted, as also the profile of the river and other data in connection with the general survey, in order to secure a proper oversight as to the flow and to determine the best location for the power house.

The first cost, efficiency, and economy of a hydroelectric development, depend to a large extent upon the ability of the designer. It should be the ultimate aim of the engineer to produce and distribute electrical current at a minimum cost. It is not the province of the designing engineer of a hydroelectric plant to design any particular machines, such as turbines, generators, oil switches, etc., but to provide a selection of various makes, each designed to perform its functions in the most economical manner; and to have these machines in proper combination to form one complete unit for the purpose of generating electrical current from water power on a commercially satisfactory basis. Great care must be exercised on the part of the designer, for instance in selecting turbines suitable to the head; a turbine designed for a low head would not be efficient if used with a high head. It is just in this connection that mistakes in selection have been exceptionally frequent in American practice, thereby materially cutting down the efficiency of the turbine and simultaneously the economy of the plant.

The work embodied in a complete hydroelectric undertaking embraces hydraulic, structural, mechanical, and electrical engineering, yet in order to secure harmonious co-operation, it is essential that the whole undertaking should be directed by one head. As most developments, particularly those of great magnitude, are far distant from the engineering organization and, as in many instances, the original plans cannot always be strictly adhered to, the resident engineer should be a thoroughly capable man and should have sufficient authority to make necessary changes, which though trivial in themselves may seriously affect the remainder of the plant. Of course all such changes undertaken must be promptly reported to headquarters, that they may be noted and the original plans properly amended.

TIMBER DAM, CAZADERO, PLANT OF THE PORTLAND RAILWAY & POWER COMPANY, PORTLAND, OREGON.

A type once common in America.

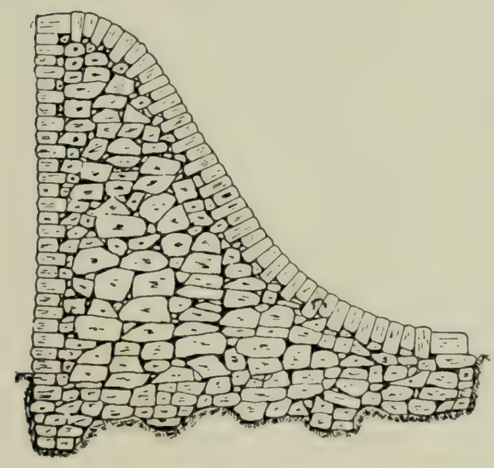
DAMS.

Of the many kinds of dams in use for hydroelectric installations the masonry dam is the most common. It is either of the gravity or arch type. The stability of a gravity dam depends upon its own weight, while that of the arch-type dam depends upon a trussed action at its ends which rest against mountain sides. A combination of these two principles is, of course, often found in one dam.

All gravity dams must rest upon solid foundations, and where these do not already exist an artificial one must be created, preferably by driving piles which may be wooden, concrete, or sheet-steel. Incase there exists a rock bed it must be cleared of all earth and loose boulders, and some offsets (preferably in the form of trenches) must be made to prevent sliding. The bottom of the dam, in all cases, should extend at least five to six feet below the river bed, so as to prevent leakage of water under the dam, which has been the cause of many failures of solid masonry dams. Where treacherous ground is found sheet piling should be driven to a proper depth to prevent such underflow. Of course, before the location and the type of dam are decided upon soundings must be properly made to ascertain the condition of the bed as well as the underlying strata. In case of high dams where a great volume of water is impounded, the tests must also be made upstream and above the dam in order to prevent seepage due to the greater hydrostatic head. This is a factor which has evidently been overlooked in many installations. While records of the annual rainfall and evaporation as well as computations of the consumption of water are at hand, the loss of water usually cannot be accounted for. The remedy after completion of the work, when the water has already been impounded, is a costly one, and may consist in applying a layer of concrete over the entire surface of the bed of the pond.

In the selection of a site for solid masonry dams, particularly when they are of large size, the proximity of a stone quarry should be taken into consideration.

The majority of masonry dams are made of solid concrete or of cyclopean masonry. The mixture of the concrete dam is 1:3:6 or 1:4:8. However, coarser mixtures are also used, known as rubble concrete. Where large dams are to be built, cyclopean masonry is given the preference, the stone varying in size from cobble stones to sizes of one to two tons. The stones are so placed that the smaller stones fill up the spaces between the larger ones, the whole being imbedded in concrete mortar. Such dams must be properly faced, rough-faced stone sometimes answering the purpose, and in order to make these as well as all types of masonry dams watertight, the upstream



CROSS-SECTION OF CYCLOPEAN DAM, HUDSON RIVER ELECTRIC POWER CO.

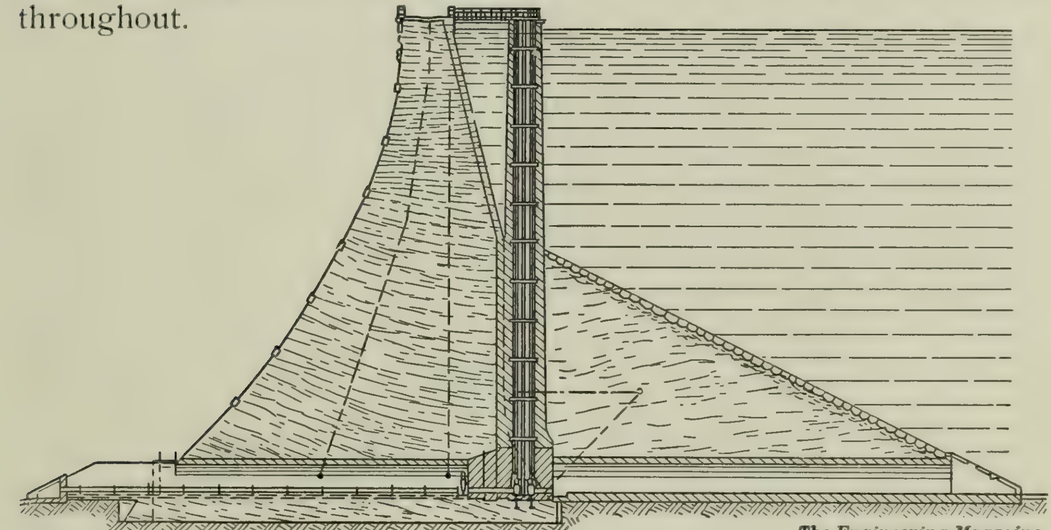
DAM AND SPILLWAY, PLANT OF THE GREAT NORTHERN POWER COMPANY, DULUTH, MINN.

side of the dam must be faced with a mixture of rich cement mortar or a course of finer concrete. Where the dam is used as a spillway the downstream face must be made to conform to the curve taken by the overflowing water, and in order to prevent erosion the toe must also be curved to form an ogee, which at the same time serves to prevent the forming of a vacuum by the overflowing water.

An example of a good dam is shown in the illustration on page 31 representing the cyclopean masonry spillway dam of the Hudson River Electric Power Company at Spiers Falls, New York.

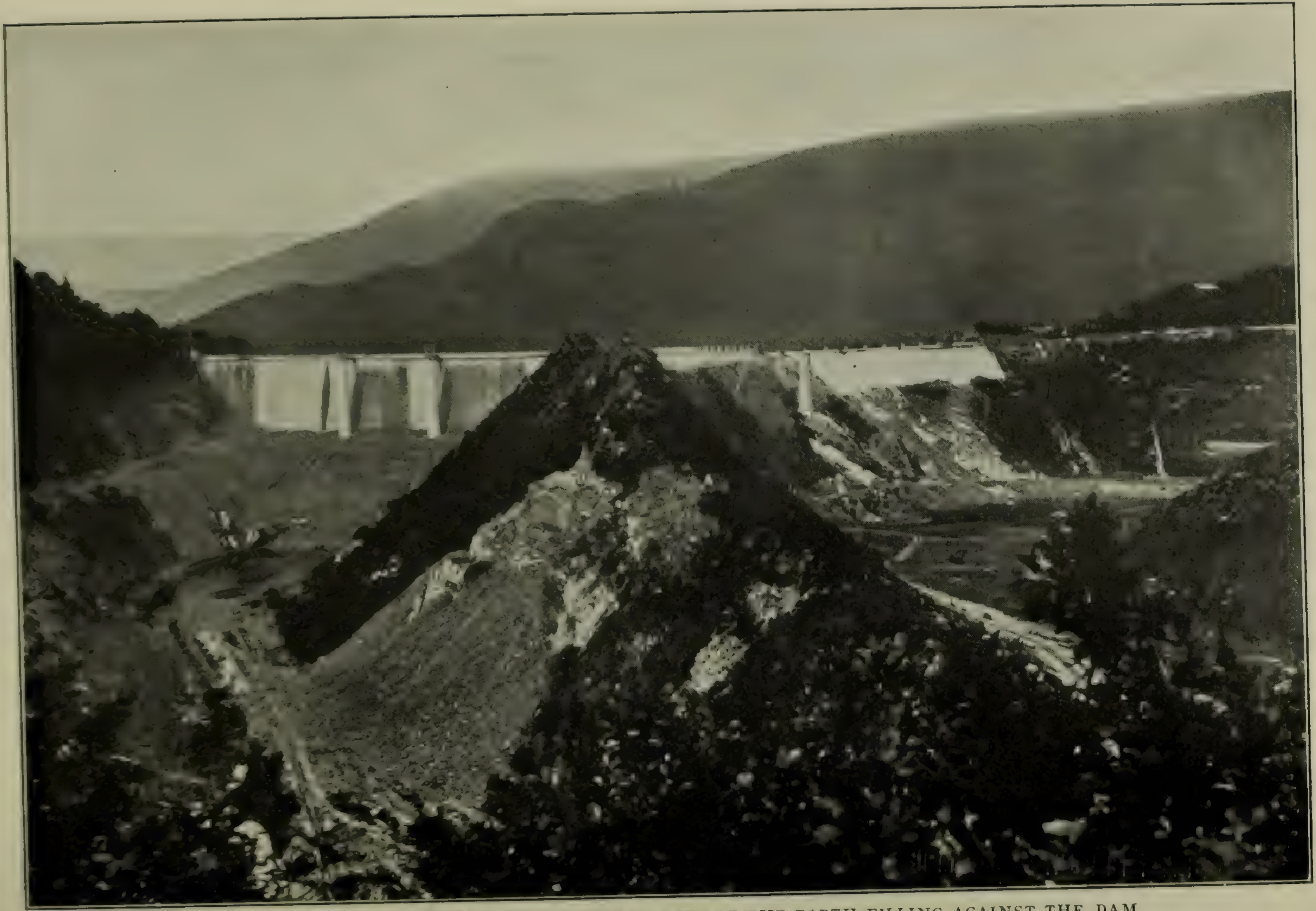
A unique dam, varying in many respects from American practice is that of the "Urfttalsperre" plant in Germany, herewith represented, and as it contains many notable features a short description of the construction may be of interest.

The dam is 190 feet high, having a width of 165 feet at the bottom and 17 feet at the top. It is built in arch form with a radius of 500 feet, giving the crown a total length of about 1,000 feet, 300 feet of which is used for spillway; the water flows over in cascades. The dam itself is constructed of cyclopean masonry, the largest of the stones being of a size which requires two men in handling. It is built in one continuous mass, for which purpose three timber towers were erected for elevating material. From these tracks lead across the dam and by means of turntables cars were placed on longitudinal tracks. The mortar is composed of lime, sand, and trass. Cement was not used because it was feared that the cement would harden too quickly and unequally throughout the mass, thus producing unequal stresses, which usually causes the cracks in dams. This trass, a volcanic material, also used in making earthenware, was used by the Romans, and some underground Roman works were found in this locality in the construction of which this material had been used. These were found to be in an exceptionally good condition and its use was therefore adopted for this dam as well as for other German dams built in late years. Trass, mixed with lime and sand, forms a hard and imprevious substance which dries slowly and equally throughout.



SECTION OF URFTTALSPERRE DAM, SHOWING VALVE CHAMBER FOR EMPTYING THE RESERVOIR.

The downstream side of the dam is faced with rough-faced cut stone. The upstream side is plastered with "siderosthen," a waterproof material, then faced with tile. The dam is provided with vertical seepage pipes erected in sections which are imperfectly jointed so that the seepage water may enter the pipe at each joint. For the purpose of emptying the storage basin two discharge pipes lead through tunnels through the bottom of the dam. The gates are located on the upstream side, in valve chambers, at the bottom of two shafts which extend above high-water level. The tops of the shafts

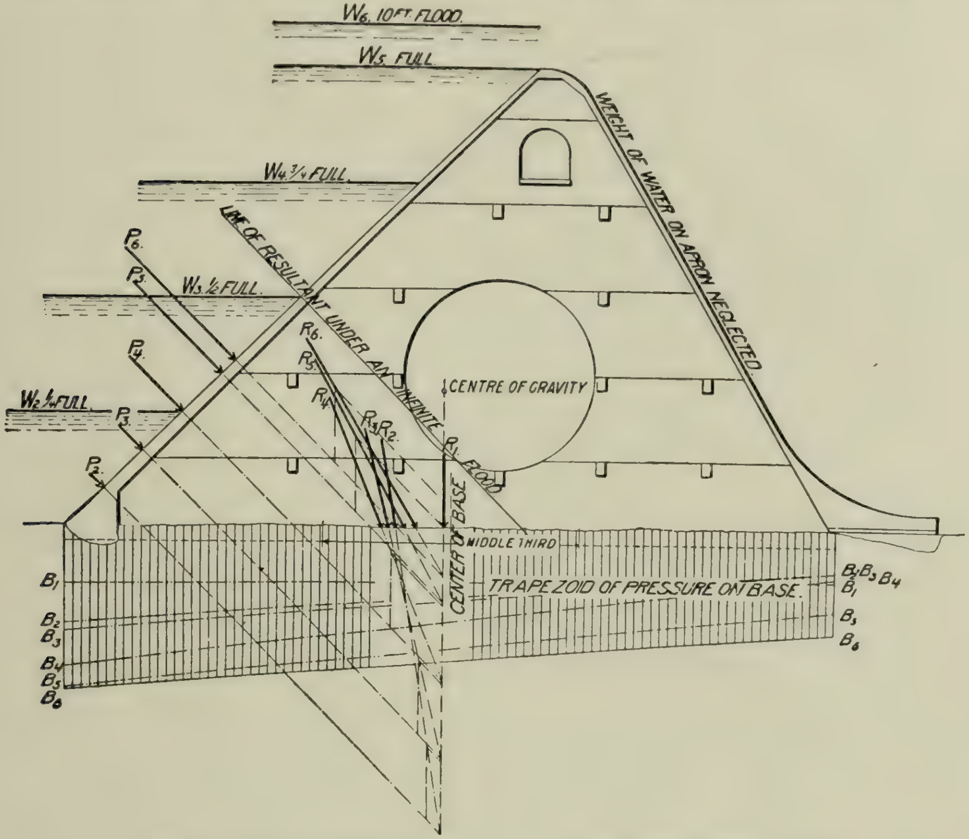


URFTTALSPERRE DAM, UPSTREAM SIDE, SHOWING PART OF THE EARTH FILLING AGAINST THE DAM.

and the crown of the dam, which serves as a roadway, are connected by bridges to permit access to the valves.

The water supply to the power house is not led from the dam through penstacks but is conducted through pressure tunnels leading through solid rock, which subject will be reverted to later.

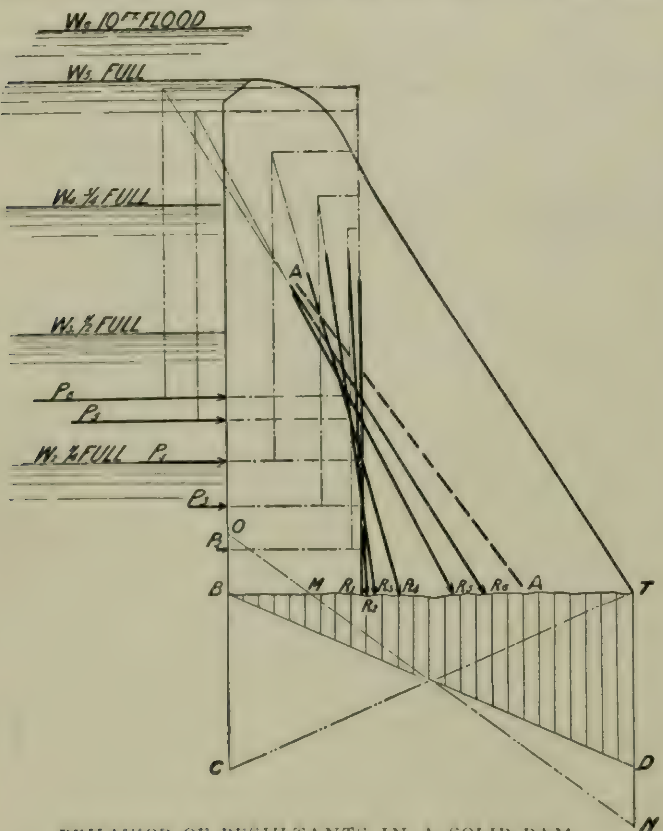
Another feature, usually not found in connection with masonry dams, is the filling in on the upstream side of the dam, to about half its height, with earth, the top of which fill has a slope of 30 degrees to the horizontal and is paved with stone. This filling gives additional security both as to stability and as against underwashing.



BEHAVIOR OF RESULTANTS IN A CONCRETE-STEEL DAM.

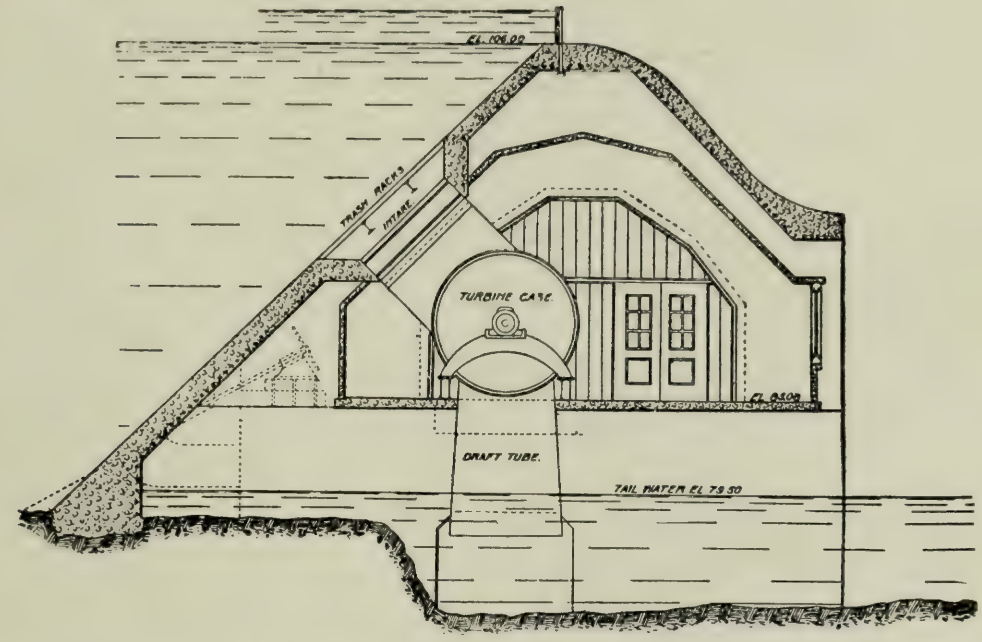
In the last five or six years reinforced-concrete dams have been much in favor for hydroelectric developments, and they display striking features of the adaptability of reinforced concrete.

The principle to be observed in the design of this type of dam is that the water pressure on the dam pins it down, consequently the upstream side of the dam, like that of timber dams, must have a long slope, whereas in solid-masonry gravity dams the pressure is exerted horizontally (provided the upstream side is vertical) tending to overturn the dam, which must therefore be made sufficiently massive by its own weight. The pressure exerted on the foundation of a gravity dam varies, theoretically, from zero at the upstream edge to a maximum at the downstream edge. The maximum must never exceed the crushing strength of the material; and usually a factor of 1.5 to 2 is employed. The slope of the "deck" of a reinforced-concrete dam may be so related to the weight and width that the pressure on the foundation is controlled by the will of the designer.



BEHAVIOR OF RESULTANTS IN A SOLID DAM.

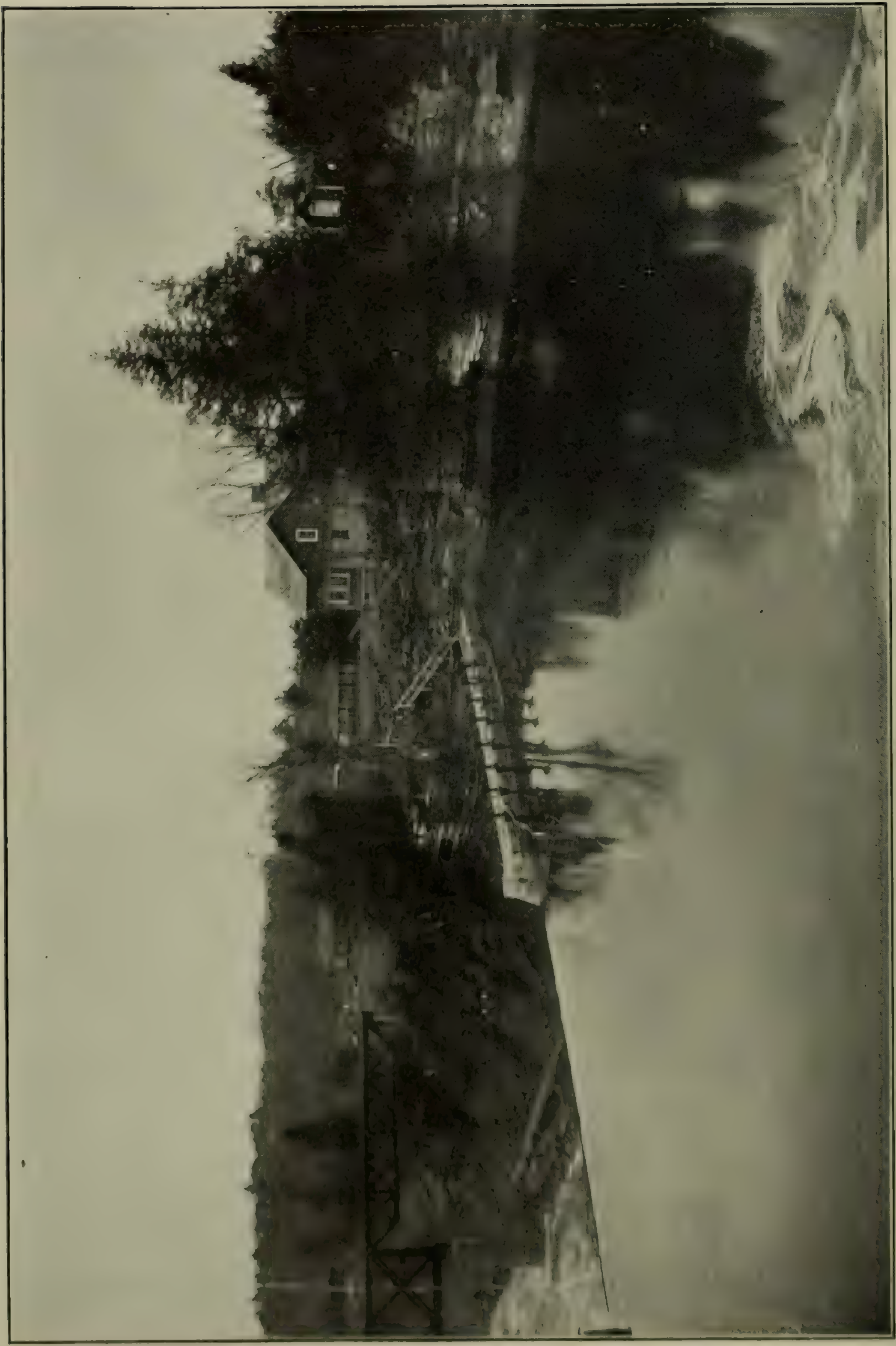
Usually the proportions are such that the diagram of pressure is nearly a rectangle; i. e., the pressure is kept substantially uniform over the whole foundation, and with the excess pressure, if any, thrown slightly toward the upstream angle instead of being concentrated at the downstream edge. This arises from the fact that the resultant of the water pressure and weight of the dam can be held at, or a little above, the centre of the base, instead of passing down to the lower edge of the middle third. The movements of this resultant and the base pressure dependent thereon may be followed in the diagram, page 35, in which the resultant, as the dam fills, is seen to advance slightly upstream from the centre, until the dam is about three-quarters full, returning again nearly to the centre, when the dam is under its calculated flood. The angle of resultant also is always kept within the limit of the angle of friction, so that the dam has no tendency to move on its base. About the simplest form of reinforced-concrete dam adapted to moderate head and hard foundations consists of a series of buttresses variously spaced from 12 to 18 feet apart, and covered with a deck of concrete reinforced between the different bases as a beam after the usual formula. The factor of safety throughout is said to be never less than five in all its relations. But little reinforcement is used in the buttress except at the edges and around the openings, which are left for convenience and to save material. The deck reinforcement, however, is abundant, and is within 1.5 inches of the lower side, leaving from 10 inches to several feet of concrete between the steel and the water. The thickness of the deck necessarily increases from top to bottom with the increase of head. The concrete in the deck is mixed 1:2:4, usually with five aggregates, and is poured into the forms in the condition known as slop concrete. This insures a thorough coating of the steel with cement, and furthermore, insures a density of concrete which seems to be sufficient to forestall porosity altogether.



CROSS-SECTION OF THE PATAPSCO DAM. A HOLLOW REINFORCED-CONCRETE STRUCTURE.

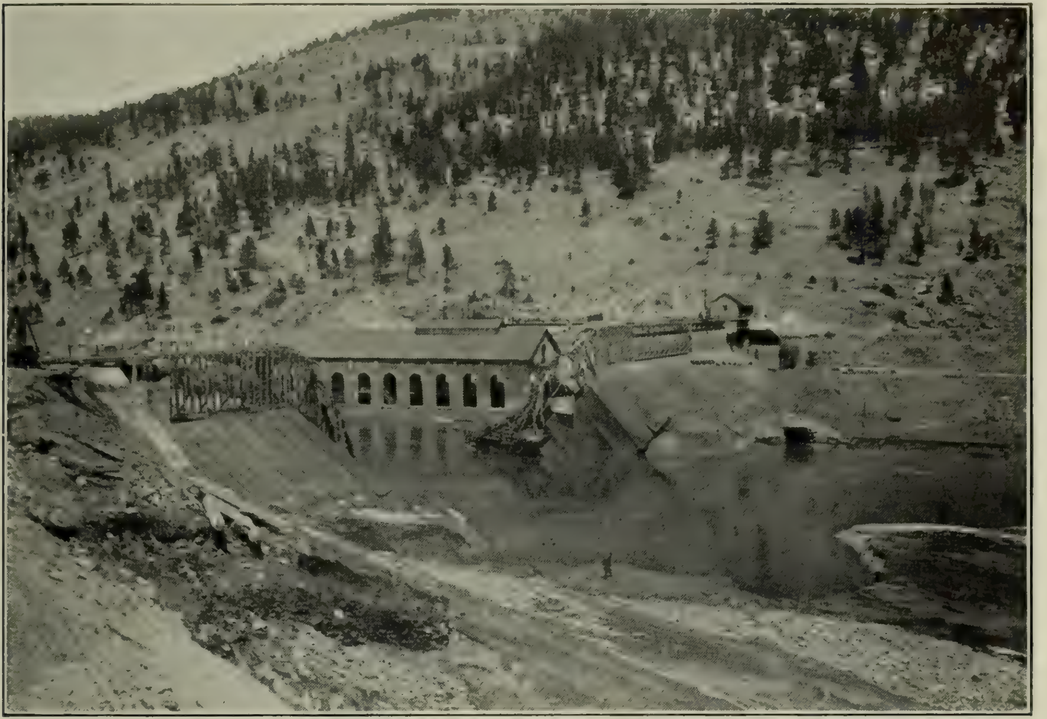
A dam of this design, when on rock, has no continuous base and therefore cannot be treated by water pressure finding its way through seams in the rock, and exerting a lifting pressure under them. On gravel or other porous foundations an artificial base is first laid down covering the entire area, but in such case this base or floor is pierced with numerous weep holes, so that upward pressure is again forestalled.

Being hollow, reinforced-concrete dams not only possess the unusual features of interior inspection, but the hollow space puts at the disposal of the engineer a valuable space from which to work the various adjuncts, such as flash boards, waste gates, log sluices, movable crests, etc., all of which are handled from the inside of the dam, allowing the whole width of the river to be utilized for rollway, instead of being more or less obstructed by bulkheads. The interior of the dam admits of plenty of space for a passage-way, which may



THE DAM OF THE UTICA GAS AND ELECTRIC COMPANY, TRENTON FALLS, N. Y.

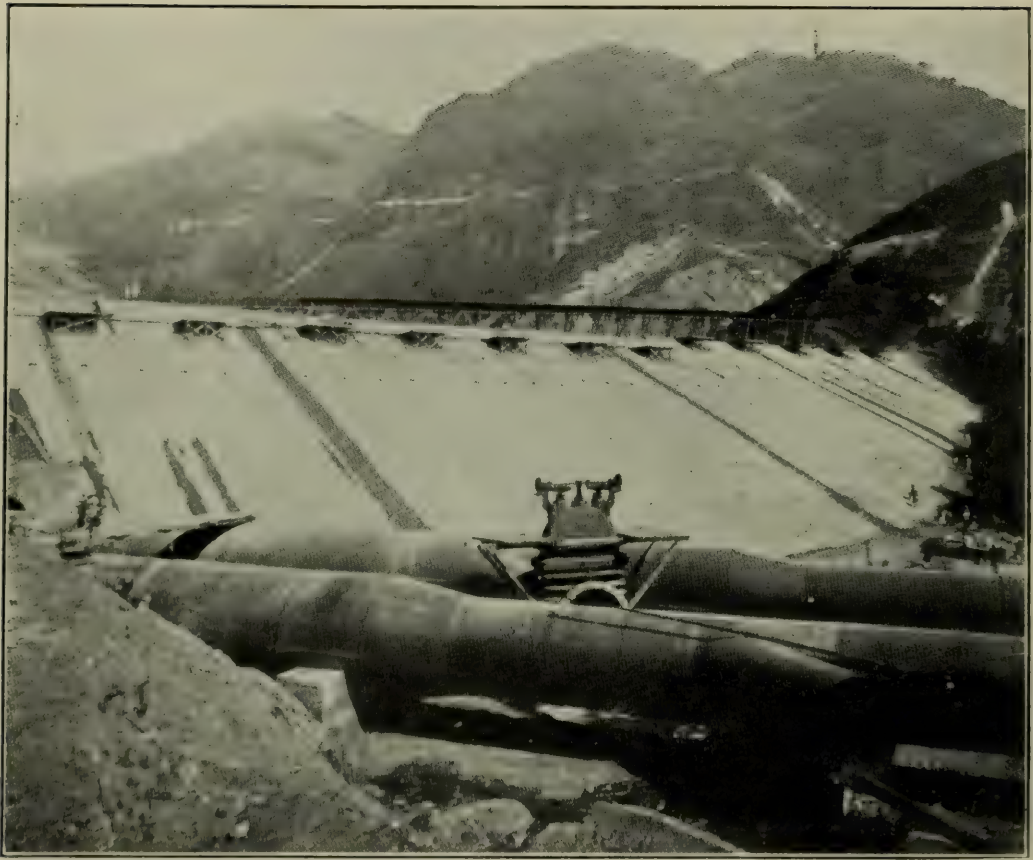
vary from an ordinary foot bridge to the equipment of a complete power plant as seen on page 38 representing a cross section of the Patapsco dam in Chester, Md. This dam is 200 feet long and 30 feet high and the interior is equipped with three 500 horse-power horizontal turbines direct-connected to generators. It contains also the exciters and other electrical features such as switchboards, etc. To guard against possible moisture the power house itself is enclosed with 4-inch walls of ferro-inclave, entirely separated from the structure of the dam itself.



BREAK IN THE HAUSERLAKE DAM OF THE HELENA POWER TRANSMISSION CO., LOOKING DOWN-STREAM.

Another feature in reinforced-concrete dam construction is the spacing of piers, which by leaving a free waterway often enables this type of dam, on certain foundations, to be built without the use of a coffer dam. Piers are first carried up in caissons to a uniform grade a few feet above the ordinary water level, and then the superstructure is completed while the water runs freely between the piers.

Of the many other types of dams the steel-frame dam is of some importance and the accompanying illustration shows such a dam erected by the Helena Power Transmission Company across the Missouri River at Helena, Montana. Its life, however, was not long. This dam was 630 feet long and 75 feet high. The lower section of the upstream side was of concrete behind which was rubble masonry; the upper section was made of structural steel trusses 9 feet 9 inches



NECAXA DAM OF THE MEXICAN LIGHT AND POWER COMPANY BEFORE THE ACCIDENT.

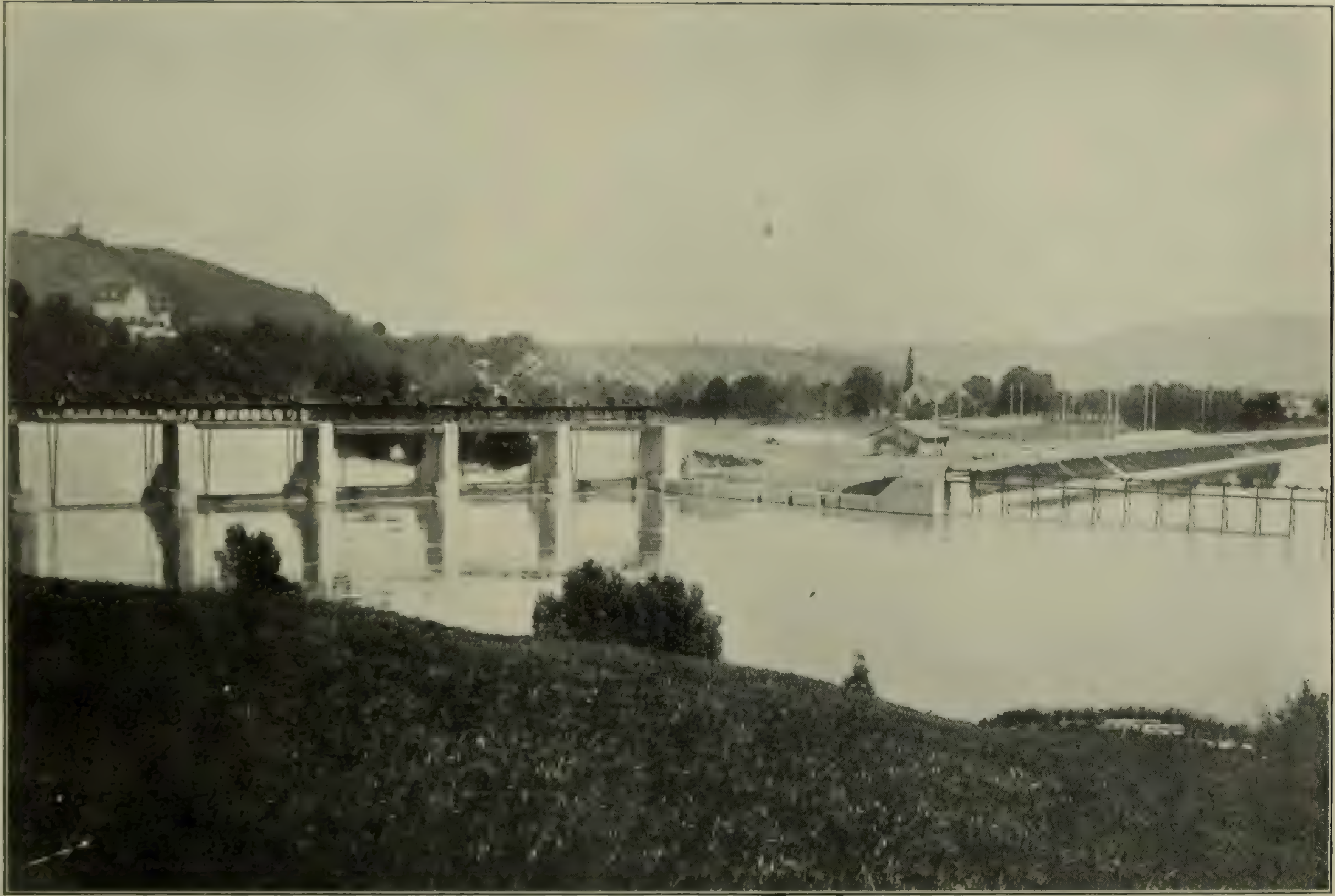
apart and faced with steel plates. In the front of the upstream concrete toe, in order to prevent water from washing beneath the dam, steel sheet piling had been driven. Only the upper section of the downstream side was faced with steel plates, the remainder of the downstream end being made entirely of wood. The top of the dam bore a flashboard structure faced with steel plates at both ends, while in the middle an opening of 50 feet was left to pass floods. This, however, could be closed after the flood had passed. This dam failed April 14, 1908, at the time when the matter of acceptance and final settlement was in the hands of the attorney of the power company. The cause of the failure was the passing of the water under the sheet steel piling, underwashing the rubble concrete, the supports for the structural steel being carried away and finally making a breach of 300 feet in width.

The earth dam is another type of dam of which many have been built of late years and many have failed. They have either a concrete earth being sluiced into place. One of this type was built by the Necaxa Light and Power Company, Mexico. It has a total height of about 190 feet, the top has a width of 54 feet, while the upstream side is 3 on 1, the downstream side 2 on 1. The dam has a total estimated contents of 2,130,000 cubic yards, of which on May 20, 1909, 750,000 cubic yards, forming part of the upstream portion, slid backward into the reservoir. The dam is made up of a puddle core, on both sides of which are mixed clay and rock and both the upstream and downstream faces are covered with heavy layers of rock. The manner of construction, as given in a paper by F. C. Pearson and F. O. Blackwell before the American Society of Civil Engineers, is as follows:

> "The ground was first cleared and stripped, and a trestle to support the flume was erected, and low earth dikes were made at the upstream and downstream limits of the fill, to hold the mud and water. The material was then sluiced in, the pipes discharging near the embankments so that the boulders and gravel were disposed at the face, and the fine mud in the centre of the dam. The dikes were raised as the dam filled and the water spilled over the upstream face into the pond. During construction the water of the river passed through the discharge gates, which were made large enough for this purpose."

It is claimed that the principal cause of the failure of the dam was the use of tepetate instead of rock, as specified, the former having a specific gravity only half as great as the latter; and as the sluicing was carried on with a great volume of water, the tepetate, because of its lightness, failed to displace the water sufficiently from the core, and the clay of which the core was made, also not being of the proper quality, did not harden, so that as at the time of the accident the water

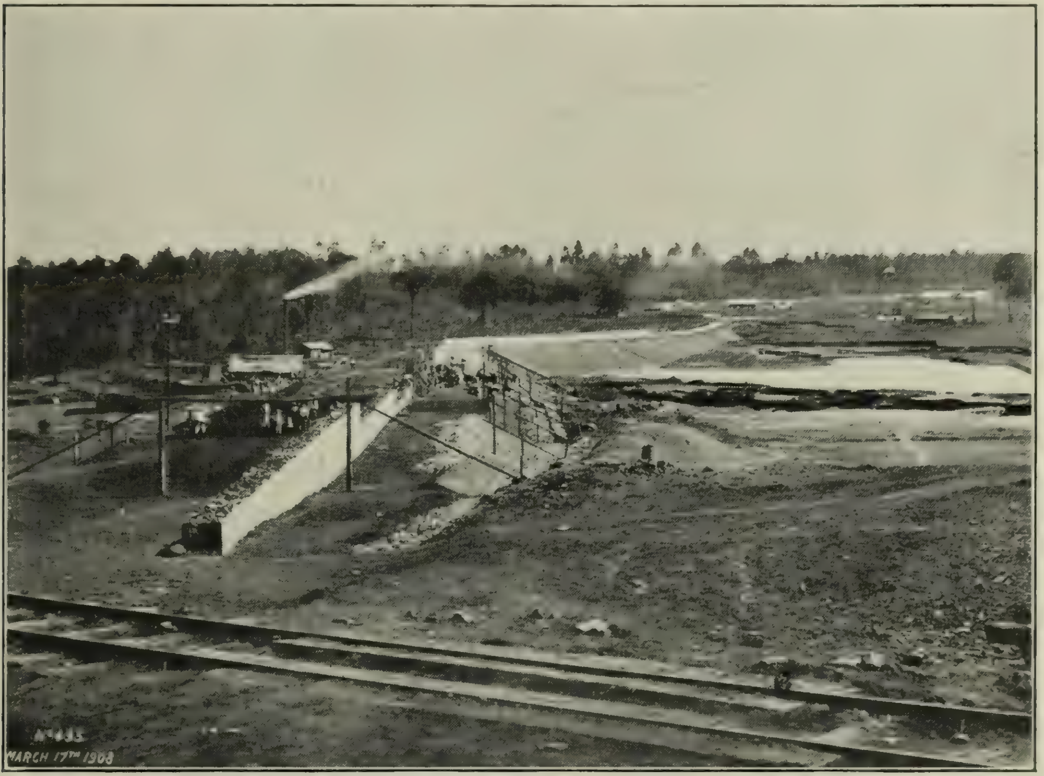
GENERAL VIEW OF THE NECAXA DAM UNDER CONSTRUCTION, SHOWING FLUMES FOR FLUSHING IN THE MATERIAL.



STONEY ROLLER SLUICE DAM AT THE BEZNAU PLANT, SWITZERLAND.

was low, the dam above the water level flowed backward into the reservoir. It is understood that the dam is at present being restored with the use of proper materials.

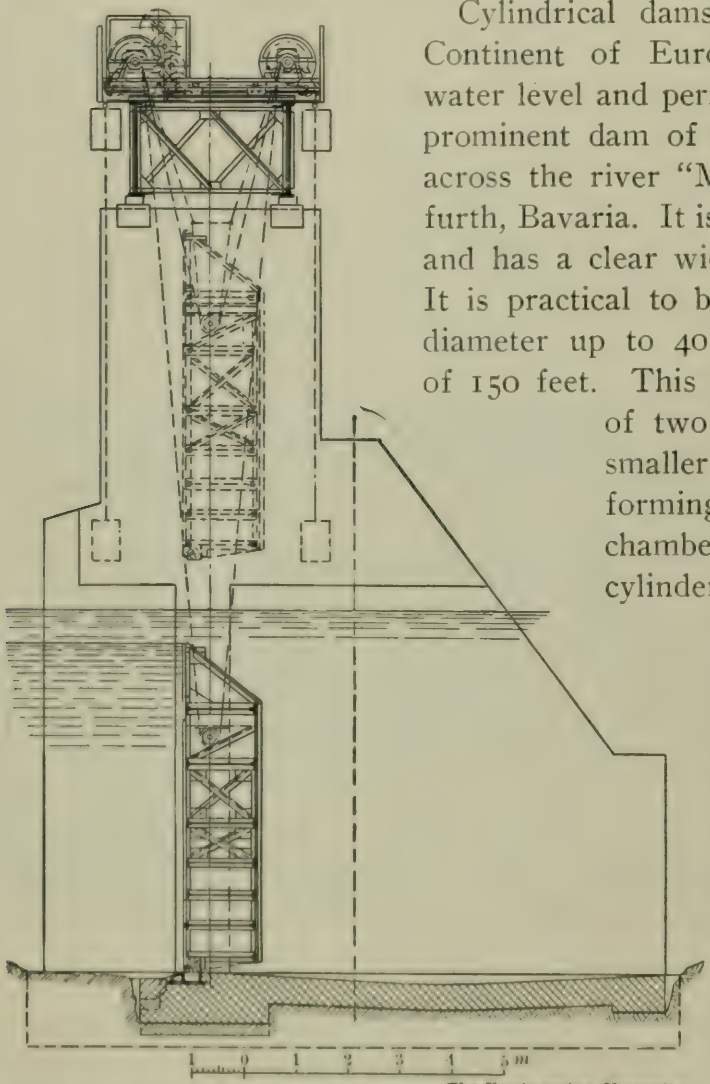
Of the many movable dams in use in connection with hydroelectric developments probably the most common are those of the butterfly type, flashboards, roller sluice gates, cylindrical dams, and so-called bear traps, all of which are designed, more or less, for raising the water level. The "Stoney" roller sluice gate is used to a great extent by British engineers, there being also a great number in Switzerland. The accompanying illustration (page 44) shows a cross-section of this type as used in the "Beznau" plant, Switzerland. The gates move in vertical grooves on roller trains in the abutting piers. Both gate and rollers are counterbalanced so that a gate under pressure can be easily moved by hand—if not exceptionally large, in which case motors or air or hydraulic pressure may be used. The discharge of the water in this type of dam takes place from beneath the gate; thus the foreign material collecting at the bottom is readily disposed of and the opening serves as a fish-way at the same time.



EARTH DAM WITH CONCRETE CORE, UNDER CONSTRUCTION.
One of the smaller dams in the Necxaca hydroelectric power development, Mexico.

An exceptionally good example of a butterfly dam will be found in connection with the Chicago Drainage Canal power plant, there being two of these installed, the one having a width of 12 feet and the other

48 feet. They are practically alike in detail of construction and in mode of operation, are built of structural steel and are 45-degree sectors of a cylinder with a 26 foot radius. By means of this dam the water level may be raised 18 feet, these gates being raised and lowered by air pressure mechanism.



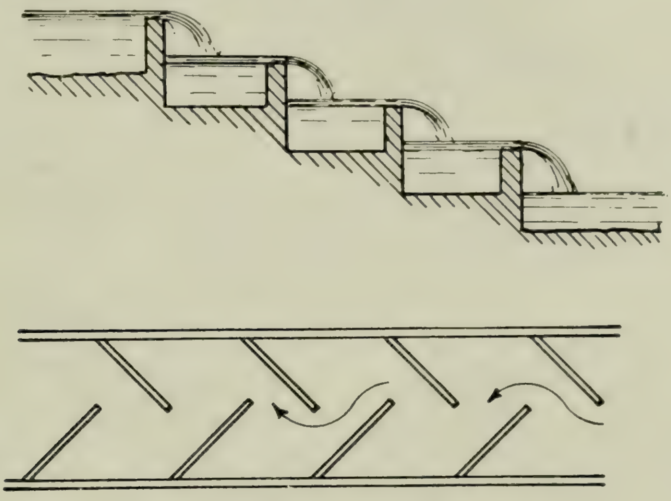
The Engineering Magazine

GENERAL ARRANGEMENT OF STONEY ROLLER SLUICE DAM.

Cylindrical dams are in use on the Continent of Europe for raising the water level and permitting navigation. A prominent dam of this type is installed across the river "Main," near Schweinfurth, Bavaria. It is 13.5 feet in diameter and has a clear width of about 60 feet. It is practical to build such dams of a diameter up to 40 feet and of a span of 150 feet. This type of dam consists of two cylindrical shafts, a smaller within a larger one, forming an annular airtight chamber. When lowering the cylinder the water flows through the inner shell and the buoyancy effect is thereby reduced. The principal advantages claimed for this type are, the elimination of piers in the middle of the river, simplicity of construction in dam as well as machinery, and ease of operation.

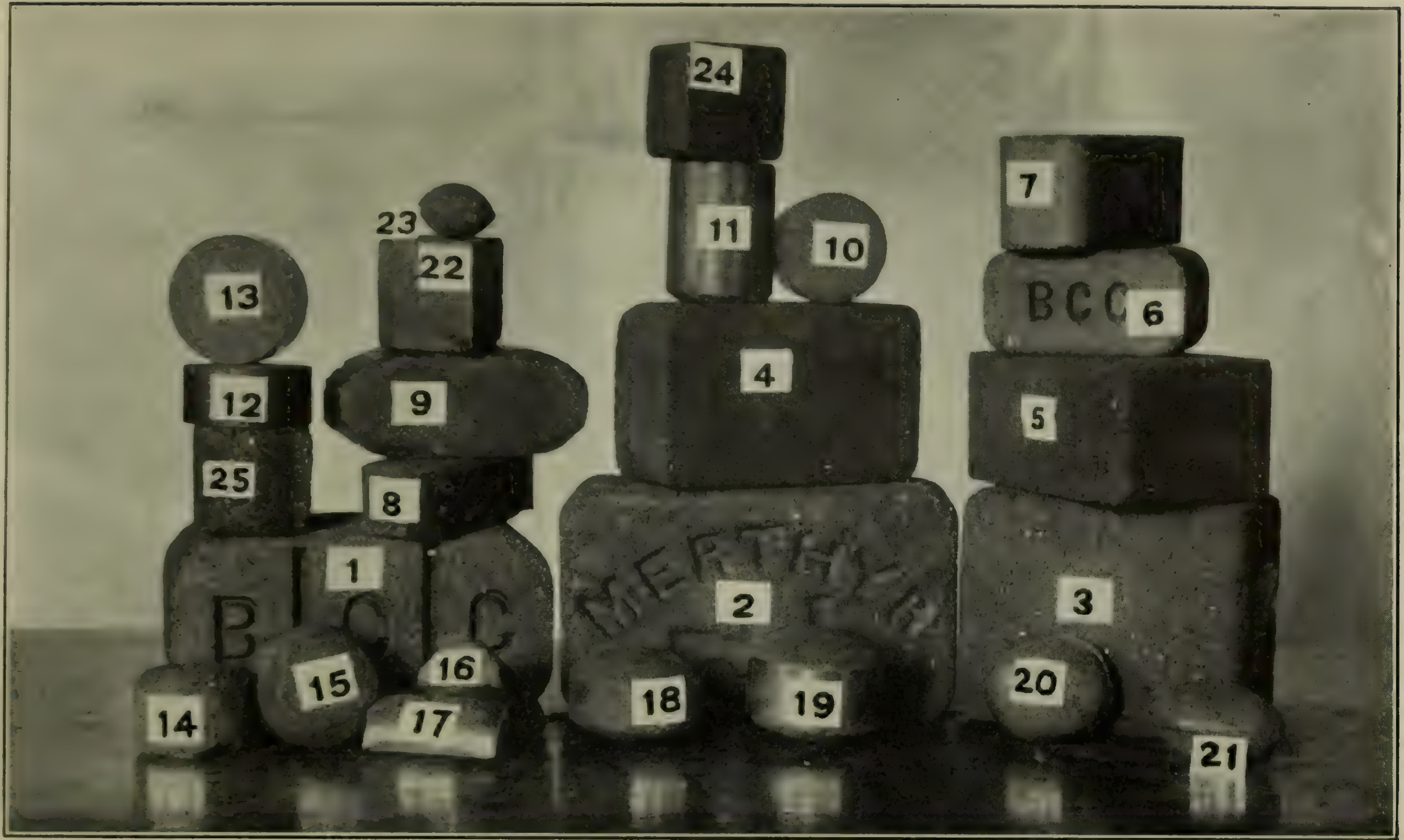
The bear-trap dam consists of two leaves hinged on a foundation, the upstream leaves overlapping the downstream leaves when the gate is lowered. A culvert leads from upstream to a point under the leaves, and a second culvert leads from here downstream; they are provided with valves. When the first culvert is open, but the second remains closed, the hydraulic pressure under the leaves causes them to rise provided the head from upstream is sufficient. Reversing the process causes the leaves to drop. The angle formed by the two leaves in their raised position should be about 100 to 105 degrees so as to operate properly under the pressure.

Flashboards are used for the purpose of increasing the head during flood periods when the tail water is higher than usual, in which event, with surplus water flowing over the crest of the dam, the head would otherwise be materially reduced. They are designed to retain a certain amount of water which would otherwise be discharged over the dam; should the pressure exceed a predetermined limit the supports give way and the boards are washed down stream. This, in any case, means a loss of planking; in many instances, however, the flash boards are removed in anticipation of high floods. Permanent flash boards of steel may be so anchored to the dam as to be tipped automatically by high floods so as to permit the water to pass, the flashboards being again placed in position after the flood.



TYPES OF FISHWAYS.

Fishways, which are usually specified by the governments, are practical passageways across dams for fish to make their periodical migration up stream for breeding purposes. They are built, usually on one side of the dam, either in the form of a chute with a series of baffles for reducing the velocity of the water, which must not be greater than 6 to 8 feet per second, or in the form of steps or cascades forming pools or resting places, the fish jumping upstream from step to step, the rise of the step depending upon the kind of fish and their habits; data on this subject can be obtained from the government or local authorities.



A GROUP OF BRIQUETS OF AMERICAN AND EUROPEAN MANUFACTURE.

1. Made by Briquet Coal Co., of Staten Island, N. Y., now located at Murphysboro, Ill. 2. Briquet made in England or Wales for locomotives or steamships. 3. Made by U. S. G. S., on English machine with bituminous coal and water-gas pitch. This was original size of briquet produced by the English (Johnson) machine, but the mold plate was reduced in thickness to make briquets of shape and size shown by 4 and 5. 4 and 5. Made by U. S. G. S., on English machine. 6 and 7. Small briquet made by Briquet Coal Co. 8 and 9. Made from California lignite on German (Exter) press at Pittsburg plant of U. S. G. S. 10 and 11. Made on Ladley press of National Pressed Fuel Co., at Indianapolis, Ind. 12 and 13. Made from California lignite on hydraulic hand-press at Pittsburg plant, U. S. G. S. 14 and 15. Peat briquets made by wet process on open mold machine. 16 and 17. Peat briquets made by Milne patent process. 18 and 19. Made on Renfrow press at Norfolk plant of U. S. G. S. 20 and 21. Eggettes made on roll type of press of American Compressed Fuel Co., of Chicago, Ill., at St. Louis plant of U. S. G. S. 22. "Industrie" (German) lignite briquet. 23. Coalettes (small eggettes) made from anthracite culm and coal tar pitch by the National Briquet Machinery Co., Brooklyn, N. Y. 24. Made from peat with 50 per cent. of a mixture of oil and asphalt by the U. S. Briquet Co., San Francisco, Cal. 25. Made for domestic use from coal yard screenings and asphaltic pitch by J. R. Allen, Summerville, Cal.

THE FUEL-BRIQUETTING INDUSTRY.

By Charles L. Wright.

Published with the Approval of the Director of the U. S. Geological Survey.

Mr. Wright is Assistant Engineer, U. S. Geological Survey, in charge of the fuel-briquetting section. He had charge of the chemical and physical tests of briquets and binders at the St. Louis Fuel-Testing Station, superintended the installation of the Government briquetting plant at Norfolk, and later succeeded to charge of the briquetting investigations and installed the briquet plant at Pittsburg, Pa. His article is prepared under the auspices of the U. S. Geological Survey, as a concise and comprehensive review of the "State of the Art." This initial section on plant, materials and processes will be followed by a second largely illustrated part descriptive of equipment and machinery for briquetting, a discussion of the properties of briquetted fuel, and some statistics of production.—THE EDITORS.

IN many industries, by-products which were at first only waste materials and troublesome to dispose of, after investigation, have been utilized with a resulting profit that was not considered possible at the beginning. In the coal-mining industries of the United States the utilization of mine waste is at the present time receiving much more attention than it ever has in the past, as mine owners are realizing that by means of briquetting and the gas producer this waste can be converted into fuel suitable for any purpose, at a sufficient profit to warrant the investment required to install the necessary machinery. It is the purpose of this article to discuss certain features of the briquetting process and its value to the coal-mining industry of this country .

In England the manufacture of briquetted fuel has opened up wide channels for the consumption not only of the immense quantities of slack obtained wherever mining operations for coal are carried on, but also for the almost equally large bulk of pitch resulting from the operations of the tar industry.

In Germany the lignite briquetting industry has developed rapidly since it was placed on a commercial basis about thirty years ago, and it is reported that German briquetting companies are now paying 15 to 20 per cent yearly dividends.

Definition of Briquetted Fuel.

The term "briquetted fuel" is applied in the United States to that form of artificial fuel which is prepared by compressing into molds the finely divided product from coal and lignite mining, this product in most cases requiring the admixture of a bonding material or binder to hold the particles together, although certain lignites possess sufficient natural bituminous matter to cohere without addition of artificial binder, if subjected to very heavy pressure in the molds.

Historical Statement.

According to Menzel, the oldest record states that ball-shaped compressed coal originated in China. Hugh Platt in 1603 described in a pamphlet a new compressed fuel manufactured in the year 1594 in the neighborhood of Lukeland in Germany; made of coal-dust, sawdust, and oak tan-bark with cow-dung as a binding material.

Jars in the year 1776, Clire in 1813, inform us that near Achen and Luttich balls and eggs were made from coal dust with 10 to 15 per cent of loam, for house fuel.

In 1799 Chavanne received an English patent on the application of coal formed in the shape of cakes.

In 1832 E. Marsais patented in St. Etienne a method of preparation of pressed coal, from a mixture of coal tar and slack. His briquets, however, were not hard enough.

In 1842 Marsais obtained a patent for the use of soft coal-tar pitch as a binding material, and erected in Berard, near St. Etienne, the first briquetting plant, and four years later he erected the second briquetting plant at Givors.

In 1843 Wylam used hard coal-tar pitch as a binding material for slack coal, and in 1846 the first briquetting plant in England was established at Newcastle-on-Tyne.

In 1852 the first Belgian briquetting plant was erected at Montignies-sur-Sambre.

In 1858 Austria's first briquetting plant was erected at Brandeist near Prague.

The first German briquetting plant on record was erected at Mulheim-on-the-Ruhr in Prussia in the year 1861.

In 1867 France already had thirty-one briquet manufactories which produced annually more than one million tons of briquets.

In 1869 Belgium had nine briquetting plants with a yearly production of 515,000 tons.

The first briquetting plant in the United States, according to C. T. Malcolmson, (*a*) was established in 1870 by E. F. Loiseau at Port Richmond, Philadelphia.

Fuel Briquetting Plants in the United States.

Several plants have been established in different parts of the United States since 1870, but only those established in the last five years have been successful on a commercial scale.

(*a*) Briquetted Coal and Its Value as a Railroad Fuel. Roberts and Schaefer Company, Chicago, 1909.

In 1908, according to E. W. Parker (*b*) the following plants in the United States were in operation or nearly completed; Standard Fuel Company, Birmingham, Ala.; Western Fuel Company, Oakland, California; Arizona Copper Company, Clifton, Ariz.; Indianapolis Pressed Fuel Company, Indianapolis, Indiana; Semet-Solvay Company, Detroit, Michigan; Western Coalette Fuel Company, Kansas City, Mo.; New Jersey Briquetting Company, Perth Amboy, N. J.; Robert Deviller's Plant, Brooklyn, N. Y.; D. Grieme Coal Company, New York City; The Briquet Coal Company, Murphysboro, Ill.; The Scranton Anthracite Briquet Company, Dickson City, Pa.; Rock Island Coal Mining Company, Hartshorne, Oklahoma; United Gas Improvement Company, Point Breeze, Philadelphia, Pa.; Northwestern Improvement Company, Tacoma, Washington.

There are several other plants in process of erection or not at present in operation.

The plant at Bankhead, Alberta, in British Columbia, has the largest output of any plant in America, its production during the season of 1908 and 1909 having been about 140,000 tons of 1⅞-ounce briquets made from western anthracite coal.

There are several reasons for briquetting fuel, the most important of which are the following

1.—To convert mine waste into a commercial fuel.

2.—To utilize the low grade fuels, such as lignite and sub-bituminous coals, peat, etc., and convert them into fuels suitable for local use where they are found.

3.—To produce a satisfactory household fuel from bituminous coal, or refuse from coal yards.

1.—In the modern methods of mining bituminous and anthracite coals, large quantities of slack and culm are produced; and while in some sections of the country there is a market for the slack, for use in industrial plants provided with mechanical stokers, yet in other sections of the country there is not only no market for the slack, but the mine owners are put to a positive expense to haul it away from the mines and dump it in great piles which frequently become fired by spontaneous combustion, being gradually consumed. For this reason the coal-mine operators are at the present time interested in the development of the briquetting industry in the United States, and even if the process should not yield much profit of itself, it would do away with the handling of the slack and convert it into a fuel that will readily sell for at least as much per ton as the best lump coal from the

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(*b*) Coal Briquetting in 1908. Advance chapter from Mineral Resources of the United States, calendar year 1908. U. S. Geological Survey, Washington, D. C.

same mine, and usually for more. This saving and utilization of a by-product is strongly to be commended as helping to conserve our natural resources, a question which is arousing so much interest and thought at the present time.

2.—To utilize the low-grade fuels of the western and southern states.

In certain portions of the United States, notably Texas, North Dakota, Colorado, Montana, and California, are found beds of lignite covering large areas and from a few inches to over thirty feet in thickness. These lignite beds are in many instances situated long distances from bituminous and anthracite fields, and the obtaining of a satisfactory fuel supply is a problem of great interest to people living in these districts as upon the solution of this problem depends the development of manufacturing industries there. Considerable interest has been manifested in the United States recently in the development of these fuel supplies of relatively low heating values. European countries have been developing and improving their low-grade fuel supplies for many years, so that at the present time the artificial preparation of such low-grade fuels as peat, lignite, and sub-bituminous and the slack of bituminous and anthracite has become an extensive industry. Briquetting and the manufacture of producer gas have been the means most generally adopted in Europe to convert these low-grade fuels into useful fuels, and the industrial success of Germany has been due in no small measure to the production of useful fuel from practically worthless raw material.

Lignites in their raw states are not satisfactory fuels for either domestic or industrial purposes, on account of their inability to resist the effects of weathering. They crumble to slack when dried, and after exposure to wet and dry weather for a few weeks they become slacked to such an extent that they are burned with difficulty and only with special apparatus. The American lignites tested by the United States Geological Survey were found to contain from 30 to 40 per cent of moisture at the mine, and this high per cent of moisture partially accounts for the low heat value and low efficiency of this fuel. In the process of briquetting lignites the moisture is reduced to 10 to 15 per cent and their heat values are thereby improved from 35 to 50 per cent. This improvement in heat value is of especial importance when the fuel is to be shipped to a market at some distance from the mine, as it saves transportation charges on the water that is removed by briquetting, this saving amounting to as much as 32 per cent in some instances.

3.—To produce a satisfactory household fuel from bituminous coal. In certain parts of the United States, notably New England, where fuel has to be obtained from mines located at a distance, the transportation charges are so great that the prices of anthracite and bituminous coals are very close to each other, so that when the added advantage of the cleanliness of the hard coal is considered it is not strange that anthracite is used for a domestic fuel to the exclusion of bituminous coal. In these sections there should be a market for bituminous-coal briquets as a house-heating fuel, as they could be made at the mines and sold at a price to compete with anthracite; and if properly made (and I must emphasize the word *properly*), the briquets should have satisfactory heating capacity and cleanliness in comparison with hard coal.

Most fuel materials can be briquetted if the proper binder is used and the proper briquetting conditions are determined. Naturally some material will cost more to briquet than others, and whether a certain fuel can be briquetted on a commercial scale with profit will depend on several conditions such as:

Cost of raw material.

Cost of binder.

Distance of market for briquets from coal fields which will govern the price of high-grade fuel in the same market.

The first two conditions the cost of raw materials do not require any discussion; but of the third it may be said that where the cost of mining is not excessive and the fuel mined is of an inferior quality in its natural state, it is sometimes the case that a high price is obtained for a good quality of fuel, shipped from a distance into the market adjacent to the mine producing the inferior coal. These conditions of inferior local fuel, cheaply mined, and a high selling price for high-grade fuel, are very favorable to the establishment of the briquetting industry, as a means of converting the low-grade fuel into a better fuel that will sell at such a price as to allow a sufficient margin above the cost of briquetting to give satisfactory returns on the investment in the briquetting plant.

Briquetting with Binders.

Anthracite culm and screenings, bituminous slack, coke breeze, and certain lignites and sub-bituminous coals, require the addition of a binding material in order to make them into briquets. It will therefore be of interest to give a brief statement about these binding materials.

Binders Used.—The largest item in the cost of briquetting, using a binder, is the cost of the binder itself; and so it is not surprising that in the last fifteen years thousands of patents have been issued in different countries for binding materials for briqutting fuels. Many of them are complex, being made up of several substances, but the greater number of them have not been found practical, as in some cases the cost was prohibitive, while in other cases the complex nature of the binder made the briquetting process too complicated.

Among the materials suggested for binders, the following may be mentioned: Clay, lime, magnesia, plaster of Paris, Portland cement, natural cement, water glass, rosin, pitch, pine-wood tar, hard-wood tar, wood pulp, sulphite liquor (from paper mills), sulphite pitch (from sulphite liquor), beet pulp, lime cake, beet-sugar molasses, cane-sugar molasses, corn starch, potato starch, flour, flax straw, flax-straw syrup, slaughter-house refuse, garbage, blast-furnace tar, producer-gas tar, illuminating-gas tar, pitches of various grades made by distilling these tars, natural asphalts such as impsonite, gilsonite, maltha, refined Trinidad, etc., crude petroleum, petroleum residum, wax tailings, acid sludge, asphalt tar, Pintsch-gas tar, etc.

Of these binders, only a few have been found practical and those in use at the present time are fewer yet. Coal-tar pitch is the binder most generally used in Great Britain, Germany, France and Belgium. The United States Geological Survey has found water-gas tar pitch an excellent binder and it is the binder most generally used on the tests made by the Survey.

Sulphite liquor and cell pitch, by-products of the wood-pulp paper industry, although at first not found satisfactory binders on account of not making water-proof briquets, have lately been used with more success and in the Pollacsek process in Hungary, cell pitch has a favorable outlook.

In this brief paper I will not try to discuss the binders in detail and those interested will find this subject treated in an admirable manner by James E. Mills in United States Geological Survey Bulletin No. 343, entitled "Binders for Coal Briquets." It would be wise, however, to describe here the following binders:

a. Coal-tar pitch is obtained from the distillation of coal tar, a by-product of the coal-gas industry. There are three grades of this pitch, namely: soft, medium, and hard pitch. Soft pitch has greater binding power than the hard pitch and therefore less of it is required, but it has the disadvantage of producing more smoke and softening at a lower temperature in the fire. All tar pitches have the disadvantage of producing smoke when burned, but as they make waterproof briquets they have been more extensively used in European countries than any other binders for making coal briquets.

b. Water-gas pitch is made by distilling water-gas tar, which is a by-product of the water-gas industry. This pitch is therefore a petroleum product, as it comes from the petroleum oil used to enrich the water gas. What was said above about the characteristics of grading of coal-tar pitch applies equally well to water-gas pitch.

c. Asphalt pitch is derived from natural bituminous rock such as impsonite, gilsonite, maltha, etc., and is probably superior in binding qualities to coal-tar and water-gas pitch, but has as yet been used only to a limited extent.

Briquetting without Binder.

Certain kinds of lignites, or brown coals, possess sufficient binding qualities to be briquetted without adding any artificial binder to them, although a much higher pressure must be used than when briquetting material with added binder, as this pressure is necessary to soften the inherent binder.

Lignites suitable for briquetting without binder are found in Germany, Austria, Italy, and the United States.

Germany is the greatest producer of lignite briquets, having made 14,227,218 tons of this fuel in 1908, while Austria comes next with 130,000 tons in the same year.

A special type of press, known as the Exter-press, is used in Germany for briquetting lignite and peat, but the latter fuel is not briquetted profitably at the present time on account of the high moisture content which must be removed by drying. Peat has been more successfully prepared for fuel by air-drying and wet-pressing in presses similar in construction to those used for making clay products.

In the manufacture of briquets certain conditions are observed, regulating shape, dimensions and weight.

Briquets are made in various shapes of which the following may be mentioned as the most important, parallelopipedon, cubical, spherical, cylindrical, with flat or convex ends, (the length of the cylinder generally being about the same as the diameter), egg-shaped, pillow-shaped, and briquets elliptical in one cross section and rectangular in the other, this latter shape being important as it is the one adopted for lignite-coal briquets in Germany.

The weight varies from less than 1 ounce up to 22 pounds, according to the shape and the market for which the briquets are made.

English block briquets weigh about 8 pounds on the average while the German brown-coal (lignite) briquets weigh approximately 1 pound each. The eggette shapes more commonly found in Belgium and France are much smaller and weigh from 1 to 6 ounces.

Good briquets should have a firmness equal to that of a good natural bituminous coal, and to obtain this strength from 5 to 7 per cent of coal-tar pitch is required with bituminous slack and anthracite culm, but certain lign'tic coals and peat possess sufficient natural bituminous matter to briquet without adding any binding material to them.

When broken, good briquets should fracture with a clean, bright, granular surface; the edge should not crumble easily.

Briquets made from bituminous slack show less than 2 per cent of disintegration in transit, while the raw fuel under the same conditions would lose from 30 to 50 per cent.

Briquets from bituminous slack or anthracite culm show an increased efficiency in combustion of from 5 to 15 per cent over the run-of-mine coal from the same mine. Lignite briquets may have an efficiency from 25 to 50 per cent higher than the raw lignite, owing to the reduction of moisture in the process.

If made with medium or hard pitch, briquets will burn with less black smoke than the natural coal.

The regular size of the larger blocks permits of an accurate consumption of fuel in a given operation by the number of blocks used.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

By Franz zur Nedden.

IV. THE TURBO-PUMP DIAGRAM.

Mr. zur Nedden's critical discussion of the centrifugal pump, the fourth part of which is here presented, has already dealt with the mechanical and hydraulic losses of turbo-pumps, solutions of the problem of balancing axial thrust, and structural features and manufacturing considerations. The instalment here published considers the turbo-pump diagram and its practical interpretation in service. Space limitations dictate the postponement until May of a concluding section on Special High-Lift Turbo-Pumps.—The Editors.

IN considering the turbo-pump diagram we must dismiss from our minds the idea of such a diagram as is obtained from the normal piston pump. The two differ radically. The diagram of a piston pump (or indeed of any oscillating machine) is indicated by the machine itself. The pen of the indicator moves up or down according to the variations of the internal cylinder pressure, and records its position on a paper drum which moves in direct proportion to the stroke. The picture portrays the proceedings within the cylinder during a single stroke. The abscissae of the diagram signify spaces, the ordinates signify forces, and consequently the area measures power.

The turbo-pump diagram, on the contrary, signifies the registration of the heads produced by the pump at different deliveries, the heads being the ordinates and the delivery abscissae. There are at present no instruments for registering these data automatically. The diagram is made by tracing a curve through a number of points determined experimentally. Its area has no direct mathematical significance.

In direct contradistinction to cylinder diagrams, it does not directly reflect the internal phenomena, but only illustrates the variations of external phenomena under varying working condition. Nevertheless it is not at all impossible to draw, from the form of this diagram, valuable deductions as to the internal operation of the turbo-pump. Above all, it is absolutely indispensable to a clear determination of the suitability of the turbo-pump for certain conditions, and it is of primary interest to the practical engineer who superintends the operation of the pump.

		Test Number.	1	2	3	4
Motor.	Observed	Number of revolutions per minute	1480	1480	1470	1465
		Indicated electric energy, KVA	51,1	62,9	82,7	84,6
		Motor efficiency according to guarantee η_M %	91,5	92,0	90,5	90,5
	Calculated	$BHP = \frac{KVA : \eta_M}{0{,}746 : 100}$	62,75	77,8	100,3	102,55
Pump.	Observed	Pressure head as indicated by by manometer, lbs. per sq. inch	148,0	130,0	65,5	4,3
		Suction head as indicated by vacuum meter, inches of mercury	7,4	7,8	8,4	9,25
		Level difference between both instruments, H_D in ft	0′ 7″	0′ 7″	0′ 7″	0′ 7″
	Calculated	Delivery, Q in imp. galls. per min	429	579	772	832
		Pressure head H_P in ft	341	300	153	10
		Suction head H_S in ft	8′ 4″	8′ 10″	9′ 6″	10′ 6″
		Total manometric head $H = H_P + H_S + H_D$ in ft	349′ 11″	309′ 5″	163′ 1″	29′ 1″
		Water horse power $HPw = \frac{Q\text{-}10\text{-}H}{33000}$	45,45	54,2	38,2	5,32
		Efficiency $\eta\% = 100 \frac{HPw}{BHP}$	72,5	69,9	38,0	5,2
		Notes.				Gauge Full Open.

Table 1.—Test of a Three-Stage High-Lift Turbine Pump, Lifting Normally 500 Gallons a Minute against a Head of 335 Feet, Coupled Direct to 75 Horse-Power Three-Phase Alternating-Current Motor, 1480 R.P.M. at 50 Cycles Constant

These diagrams are usually based upon constant or nearly constant speed of revolution. Their method of development will be clear without much additional explanation if Figure 35 is compared with Table 1. Both register the some experimental results, the one in tabular and the other in graphic form. The curves shown in Figure 35 are characteristic of normal operation of the most modern types of turbo-pump. Above the same delivery scale, but each upon its own ordinate, are plotted the three curves of effective horse-power, efficiency, and head; this last is called the characteristic curve.

What readings can be determined from this diagram?

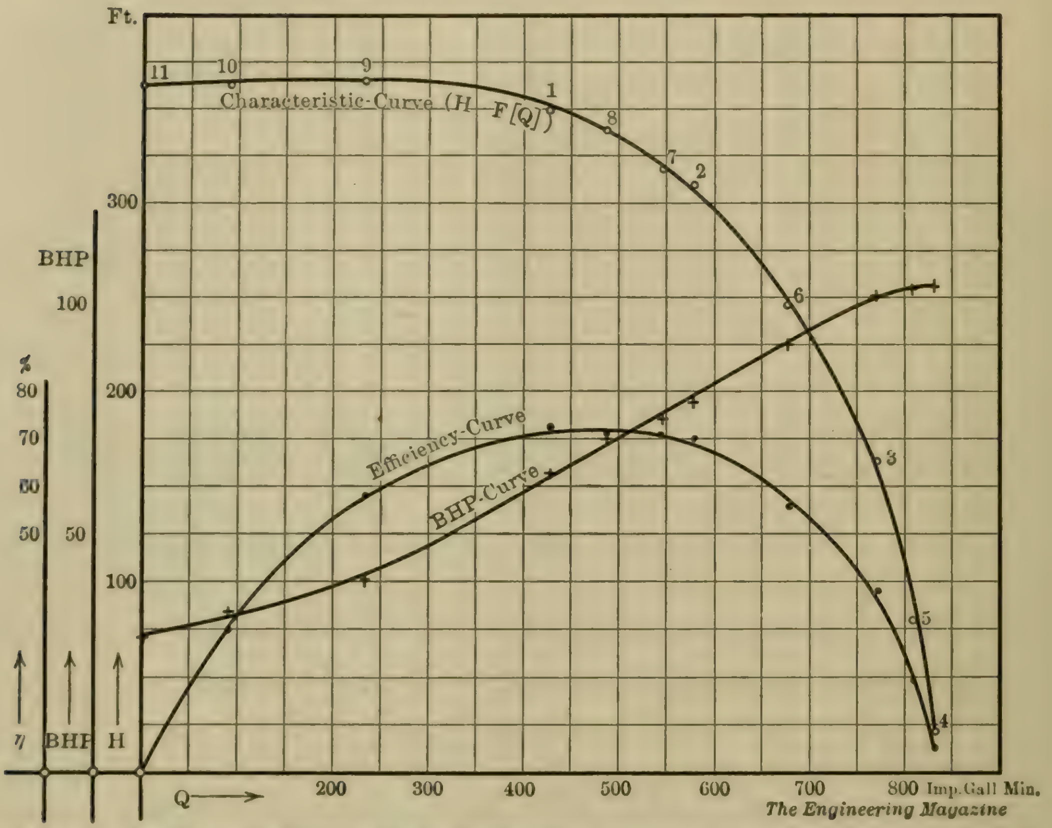
If the gate valve on the pump delivery be entirely closed (the pump being coupled directly to a three-phase alternating-current motor) the manometer on the outlet chamber shows about 360 feet head (delivery 0, point 11). If the delivery valve is gradually opened an increasing volume of water passes through the pump, the pressure remaining nearly constant, while the load demand on the motor and the efficiency rise rapidly (points 9 and 10). When the pump delivers volumes near to the normal (points 1, 2, 7 and 8) the efficiency

5	6	7	8	9	10	11
1470	1475	1480	1480	1485	1490	1490
84,1	73,8	60,1	57,2	36,8	28,5	24,3
90,5	91,	92,	92,	90,	88,	86,5
102,0	90,05	74,2	70,4	44,55	33,6	28,2
30,0	102,5	134,	143,	155,	154,	138,7
9,0	8,4	8,1	7,5	7,2	6,65	6,65
0′ 7″	0′ 7″	0′ 7″	0′ 7″	0′ 7″	0′ 7″	0′ 7″
809,	678,5	546,	488,5	234,5	91,	0
69	236	308	330	357	354′ 6″	320
10′ 2″	9′ 6″	9′ 2½″	8′ 6″	8′ 2½″	7′ 6½″	7′ 6½″
71′ 9″	246′ 1″	317′ 9½″	339′ 1″	365′ 9½″	362′ 7½″	328′ 1½″
19,5	50,5	52,6	50,1	26,0	10,0	0
19,1	56,0	70,9	71,1	58,3	29,8	0
						Gauge Closed.

TABLE I.—TEST OF A THREE-STAGE HIGH-LIFT TURBINE PUMP, LIFTING NORMALLY 500 GALLONS A MINUTE AGAINST A HEAD OF 335 FEET, COUPLED DIRECT TO 75 HORSE-POWER THREE-PHASE ALTERNATING-CURRENT MOTOR, 1480 R.P.M. AT 50 CYCLES CONSTANT (Continued).

remains fairly constant, but the pressure begins to drop, gradually at first, but faster and faster with increasing delivery. Toward the last the pressure falls very rapidly, while the delivery increases but little, and the efficiency begins to decrease (points 3, 5 and 6). The final limit of pressure is determined by the suction head, increased by the resistance of the apparatus itself (foot-valve friction and similar items) when the pump runs with the sluice valve wide open (point 4). Delivery and motor load are simultaneously at maximum. These results, it is understood, are based on the supposition of working conditions as they are to be found in the testing department of the manufacturing plant, where we are not dealing with a certain actual static head, but the resistance is produced only by variable throttling by means of a valve in the delivery pipe.

The limits of this discussion make it impossible to take up in detail the causes of this behavior on the part of the pump. We must, however, still consider the variations of this diagram which will be found when the speed of revolution (heretofore supposed to have been kept constant) is subjected to change. Delivery, of course, must vary in



The Engineering Magazine

FIG. 35. DIAGRAM OF THREE-STAGE HIGH-LIFT TURBINE PUMP, ACCORDING TO TESTS TABULATED ON PAGES 56 AND 57.

Normal delivery 500 imperial gals. per minute against 335 ft. head.

direct proportion to the number of revolutions, for it needs no argument to prove that a rotor which delivers a fixed quantity per revolution must deliver, per minute, the multiple of this quantity by the number of revolutions per minute. Head, as we have seen, depends solely upon velocity. In accordance with the hydraulic equation

$$H = \frac{c^2}{2g}$$

(c signifying water velocity and g the acceleration by gravity)

it will be clear without much discussion that when rotative speed varies, head will vary proportionally to the square of the velocity of the water, and directly as the circumferential velocity, which latter stands in purely linear ratio to the number of revolutions. Two very simple formulae for reduction thus result.

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2} \quad \text{and} \quad \frac{H_1}{H_2} = \frac{n_1^2}{n_2^2}$$

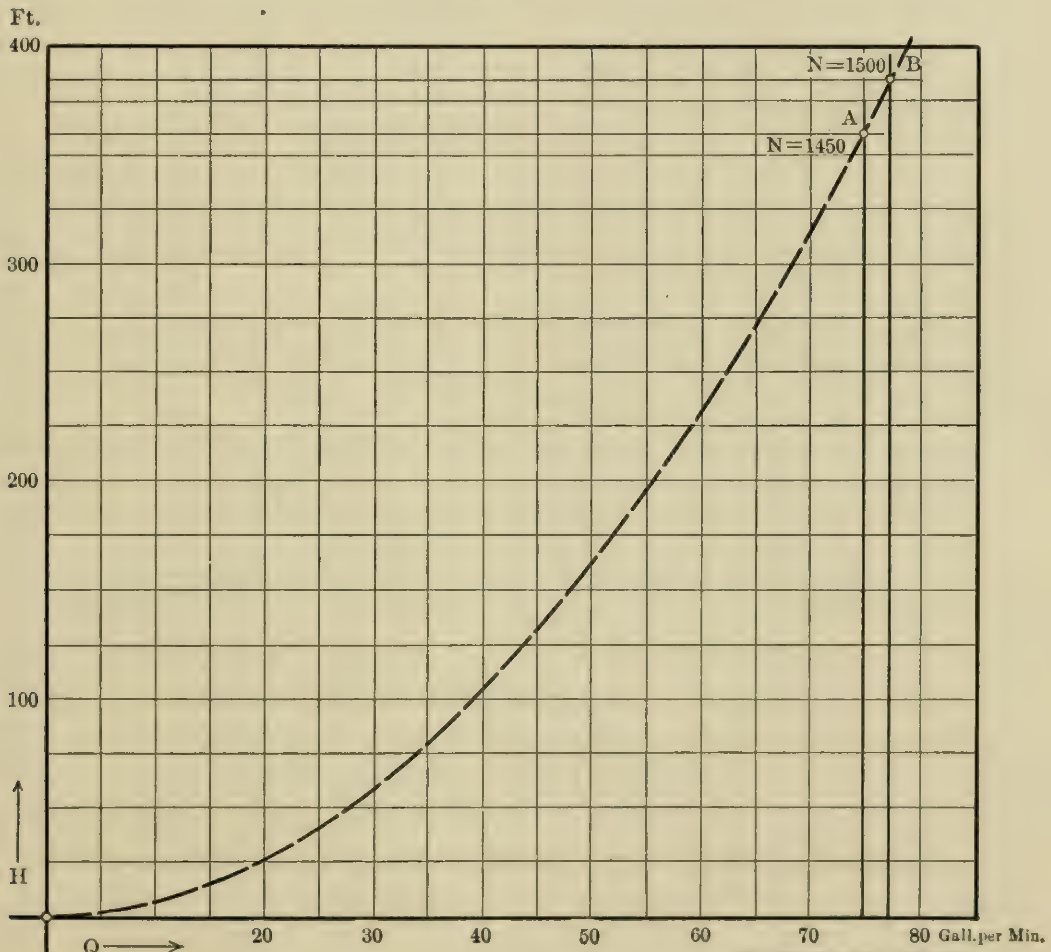
These formulae found by strictly theoretical calculation are altogether supported by practical experience. They permit absolutely reliable calculation for variations of speed. If, for example, experiment shows that a centrifugal pump will deliver 75 gallons per minute to a height of 360 feet at 1450 r. p. m. (point A, Figure 36), the question how much it will deliver at 1500 r. p. m. is answered as follows:

By the first formula above we find that the quantity delivered will be

$$75 \times \frac{1500}{1450} = 77.6 \text{ gallons}$$

while by the second formula above the head to which it will deliver will be

$$360 \times \frac{1500^2}{1450^2} = 385 \text{ feet}$$

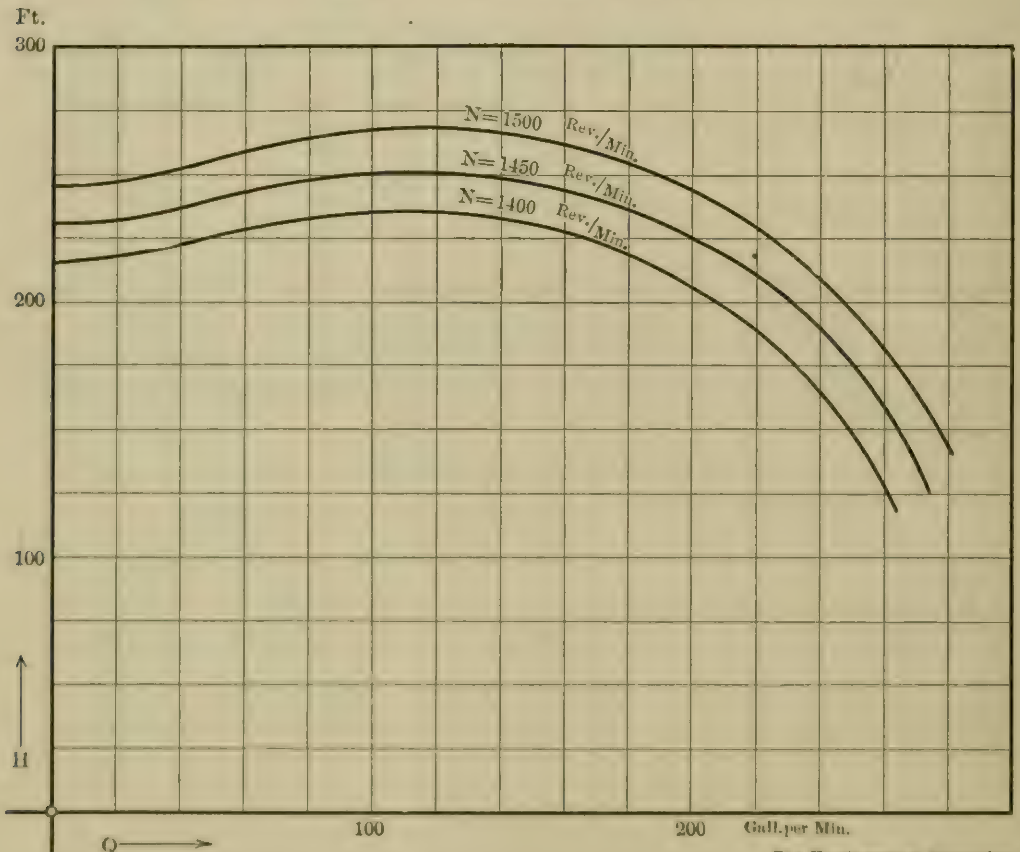


The Engineering Magazine

FIG. 36. VARIATION OF HEAD AND DELIVERY WITH VARYING NUMBER OF REVOLUTIONS.

This is shown graphically in Figure 36, B being the point reached by delivery and by head at the higher speed. Figure 37 shows the curves obtained by carrying this calculation through for all the points of the characteristic curve at three different rotative speeds.

These reductions are by no means of mere theoretical interest, nor do they apply only to special cases. Great emphasis should be placed upon the point that the form and variation of the diagram have quite as much importance in the practical operation of turbo-pumps as the question of maximum efficiency obtainable, and possibly they have even more. The following examples will justify this statement.



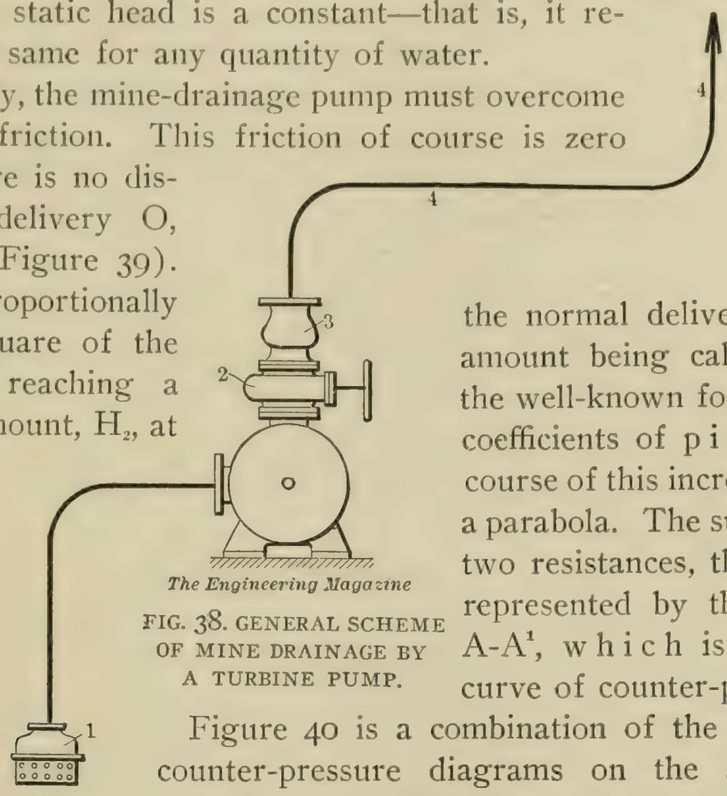
The Engineering Magazine

FIG. 37. VARIATION OF CHARACTERISTIC CURVE OF A TURBINE PUMP WITH VARYING ROTARY SPEED.

Figure 38 illustrates schematically mine drainage by turbo-pumps. The pump suction is furnished with a foot valve and strainer 1, while upon the discharge is fitted a gate valve 2 and a check valve 3, which prevents the emptying of the delivery pipe 4 by back flow when the pump is stopped. This discharge pipe 4 carries the water to the surface.

In order to see exactly the conditions which the turbo-pump must meet, we must construct a so-called counter-pressure diagram as illustrated in Figure 39. When water is raised from the sump to the surface, we must first overcome a purely static head represented by the height of the water column between the level of the sump and the center of gravity of the opening at the surface, H^1. If we make this counter pressure an ordinate upon the volume of delivery as abscissa, it will of course be parallel to the axis of abscissas A B, for in mining work this static head is a constant—that is, it remains the same for any quantity of water.

Secondly, the mine-drainage pump must overcome pipe-line friction. This friction of course is zero when there is no discharge (delivery O, point A, Figure 39). It rises proportionally to the square of the delivery, reaching a certain amount, H_2, at the normal delivery Q, this amount being calculated by the well-known formulae and coefficients of pipes. The course of this increase will be a parabola. The sum of these two resistances, therefore, is represented by the curve $A\text{-}A^1$, which is called the curve of counter-pressure.

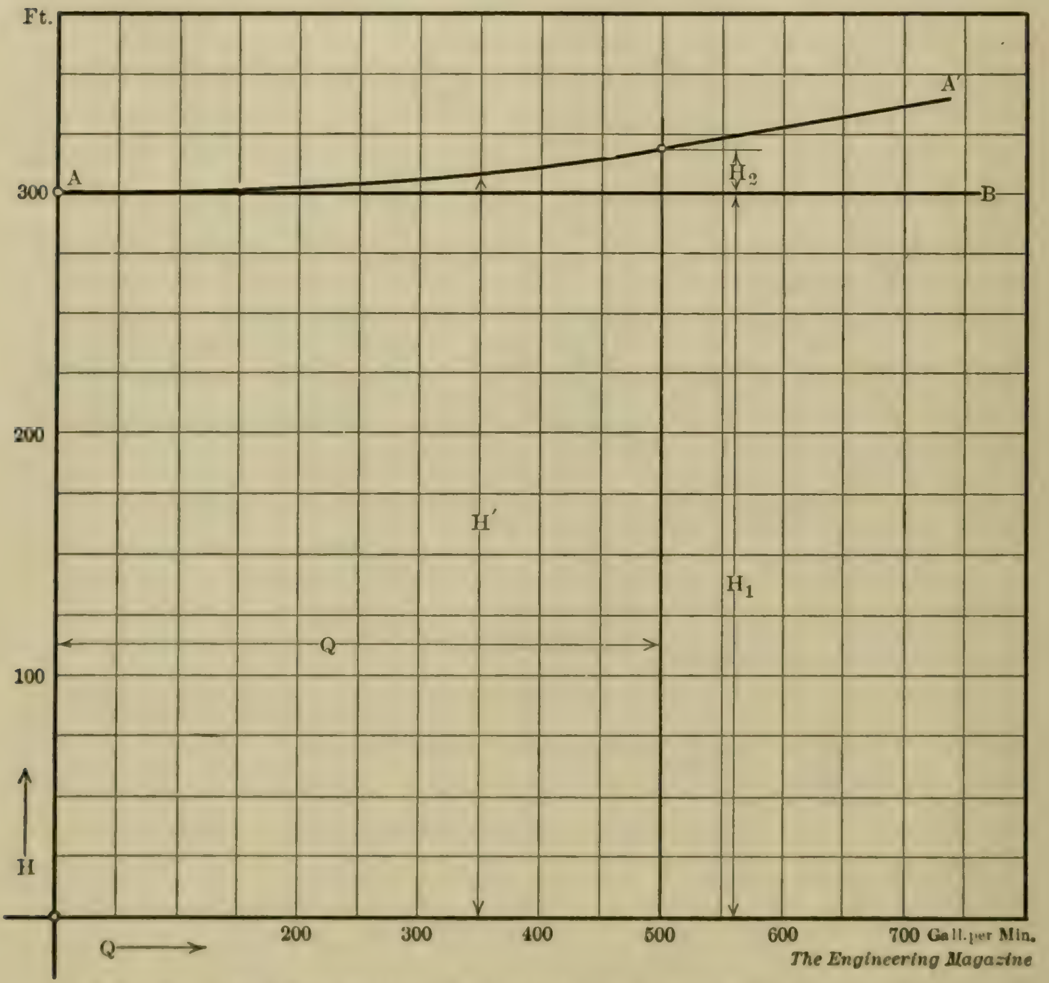


The Engineering Magazine

FIG. 38. GENERAL SCHEME OF MINE DRAINAGE BY A TURBINE PUMP.

Figure 40 is a combination of the pump and counter-pressure diagrams on the assumption that the pump which gave the results shown in Figure 35 is installed in a mine 300 feet deep, with a frictional resistance in the delivery pipe corresponding to a head of 18 feet of water column at a delivery of 500 gallons per minute. How this pump when installed can be best started may be understood from the combined diagram. After the pump has been completely filled with water, the gate valve (Figure 38) must be tightly closed. The three-phase alternating-current motor must then be brought up to normal speed. The pressure and vacuum gauges together will then show a pressure equal to 328 feet, supposing 50 circuits of the alternator. When the pump is thus started with a closed gate valve, the advantage is that the motor is not loaded at once with full load, but at first with only 29 brake horse-power. If the gate valve is now opened, the pressure of 328 feet reaching the chamber immediately under the check valve 3 will lift it instantly against the counter-pressure exerted against it by the full delivery pipe.

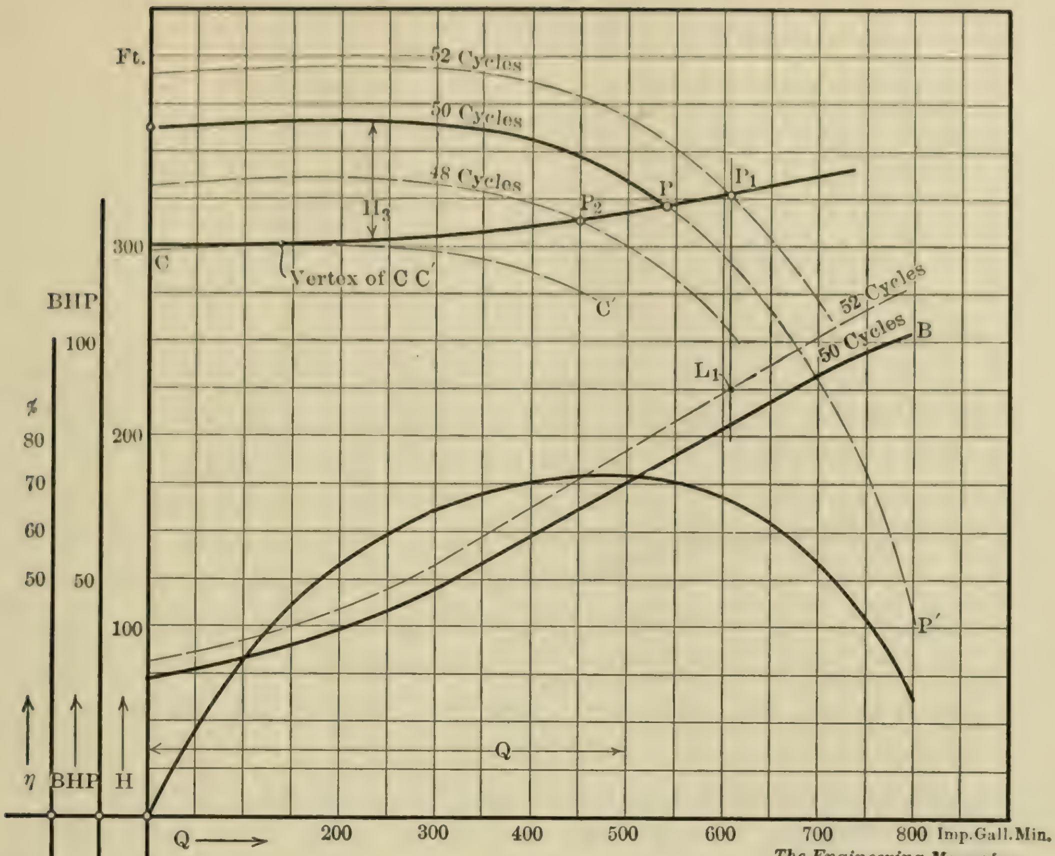
At this point an important attribute of the characteristic curve may be pointed out. Blade forms are sometimes chosen which give a diagram of which the zero point (N in Figure 40-A) lies considerably below that pressure at which the pump shows its best efficiency (point P). We can see from our combined diagram that pumps



The Engineering Magazine

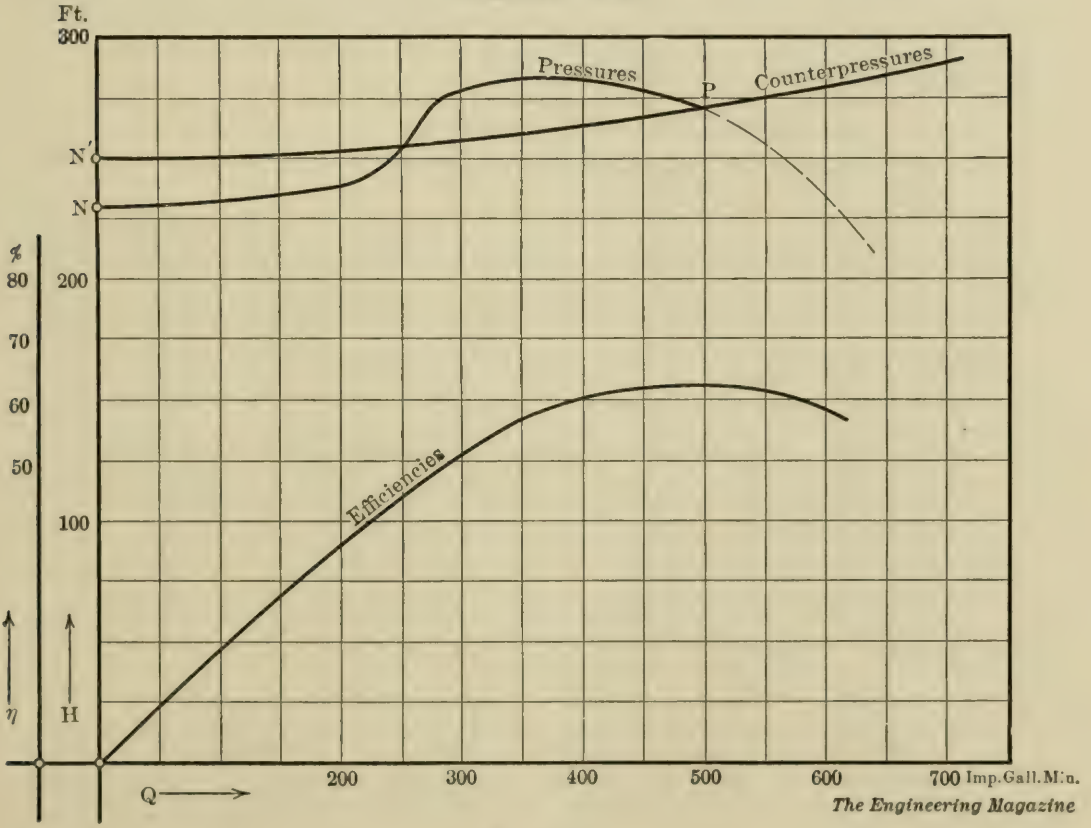
FIG. 39. COUNTER-PRESSURE DIAGRAM OF A MINE-DRAINAGE PLANT.

with impeller blades of this form can not start against a full delivery pipe except by the aid of a special auxiliary arrangement; for when the gate valve is opened the pressure below the check valve will not be sufficient to overcome the counter pressure above it, and the check valve remains closed. Such pumps can not be started except by emptying the delivery pipe to the extent of a column of water of the height N^1 N (Figure 40-A). Let us return to the diagram shown in Figure 40. When the gate valve is first opened it uncovers only a part of its area and the water is considerably throttled. The throttling resistance is added as a head H_3 over and above the counter pressure



The Engineering Magazine

FIG. 40. COMBINED PRESSURE AND COUNTER-PRESSURE DIAGRAM FOR MINE-DRAINAGE TURBINE PUMP.



The Engineering Magazine

FIG. 40A.

in the delivery pipe. This total pressure can be kept to any desired limit by a corresponding opening of the gate valve 2, and the pump can thus be made to work at an optional point of its characteristic curve. Let me emphasize that when the gate valve is opened at a regular rate the pump traverses its diagram in regular time. The motor load increases in a correspondingly smooth manner (curve B-B), the movement of the water column in the delivery pipe is gradually accelerated, and all dynamic processes take place as smoothly and as favorably as possible both for the electric and the mechanical part of the equipment. If the gate valve is finally opened wide the difference H_3 between the pump pressure and counter-pressure is reduced to zero and the pump works on the point P of its characteristic curve, .the pump pressure and the counter pressure to be overcome being in perfect equilibrium without any additional counter-pressure. In contradistinction to the conditions in the testing department, it will not thereafter work on any point of the characteristic curve lying in the portion P-P^1; hence follows a result which is of great importance, when a new turbo-pump is ordered for mine drainage. It is customary to order turbo-pumps on the same basis as piston pumps; for example, a pump is required to deliver 500 gallons per minute against a head of 318 feet at 1480 revolutions of the motor per minute, with an efficiency of 70 per cent guaranteed by the makers. The requisite power is calculated to be.

$$\frac{500 \times 318 \times 10}{550 \times 60 \times 0.70} = 69 \text{ brake horse power.}$$

Allowing an excess of 9 per cent, which the miner thinks large enough, a motor of 75 brake horse power is chosen. What would be the consequences if such a tender were construed strictly according to the precedent of the piston pump? The customer would get a pump conforming strictly to all his conditions only if the manufacturer constructed it so that its characteristic curve ran exactly through the point of 500 gallons per minute at 318 feet head. The pump we used for illustration delivers 500 gallons against a head of 335 feet. This means considerable advantage to the mining engineer. The margin of 17 feet insures that even after wear and tear has occurred, or when in the course of years the pipe area is diminished, the pump will still deliver its 500 gallons per minute. Nevertheless, the manufacturer while thus looking only after the true interests of his customer, may get into trouble. It is of course most economical to let the pump run with its discharge valve wide open, for all throttling head is loss. The pump then works on the point P. It delivers 540 gallons per minute instead of 500, but it uses 75 brake horse power, though the efficiency surpasses the guarantee by only 2 per cent. In spite of the margin of 9 per cent excess provided, the motor is loaded to its normal limit and there would seem to be good reasons for reclamation by the customer.

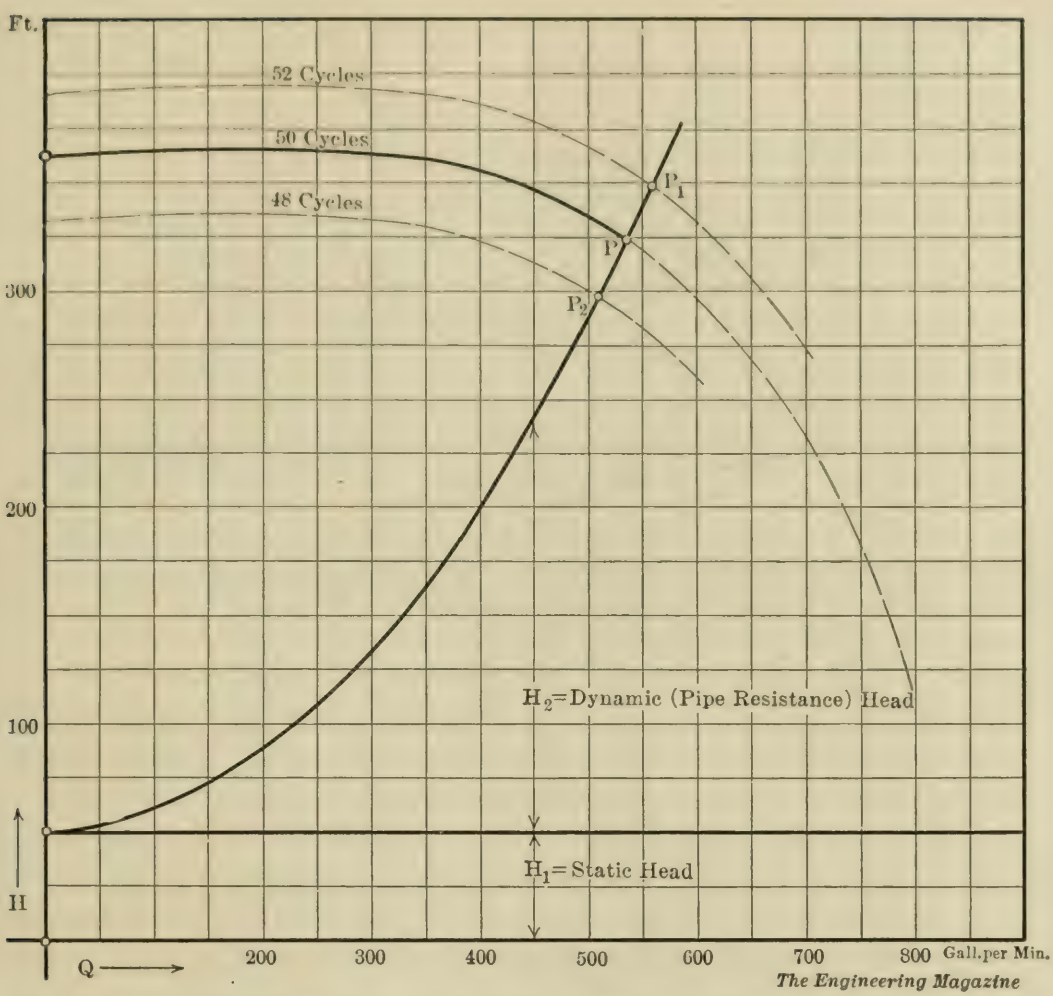
No doubt a more correct way of ordering would be to specify two limits between which the delivery must lie if the pump works against a certain head, with a certain guarantee of efficiency which must be reached. Above all, it may be learned from this that ample surplus power in the motor should always be provided. Such provision will avoid the necessity of working with a throttled discharge valve—that is to say, uneconomically, and this is not the only advantage. Furthermore, the danger of motor heating with low voltage is lessened. And, beyond all this, it should be noted that variations of rotative speed will cause grave difficulties if a motor of scant power is selected.

The influence which variations in speed exert on a mine-drainage proposition may easily be traced on the combined diagram, Figure 40. If, following the method explained in the case of Figure 37, we draw characteristic curves for 48 and 52 cycles (as dotted in on Figure 40) we see that when the speed of rotation varies the point P travels along the counter-pressure curve to the limits P_1 and P_2, the discharge valve being fully opened. Increase of rotary speed has the disadvantage that the capacity increases to a much greater extent than with piston pumps, where it rises only proportionately. At the same time the efficiency falls comparatively fast at greater delivery, so that in total the motor must work at considerable overload. For example, in Figure 40 the exact overload for the point P_1 is found at L_1. From this we can see how powerful a motor must be chosen if eventually 52 cycles instead of 50 were to be expected for any length of time and throttling of the discharge valve were not advisable.

The results which ensue if the number of revolutions falls are particularly worthy of note. The point P_2 will move further and further toward the abscissa zero, until at a certain decrease of rotary speed the characteristic curve will be transposed into the position C-C^1, only just touching the counter-pressure curve at its vertex. If the least additional decrease in the number of revolutions is made thereafter the pump pressure falls below the counter-pressure, the check valve closes, and the delivery being entirely cut off, the pump pressure goes back to the point C; it "snaps off." It is unable to reopen the check valve until the zero pressure has risen above the static counter-pressure of the delivery pipe. At that moment the pump endeavors to traverse instantaneously the whole convexity of the characteristic curve about to the point P_2. In this process the motor is first loaded with a sudden jerk, and next the sudden acceleration of the water column (which has slowed down in the interval) throws upon the pump a reaction which may rise to more than a ton and may even cause shaft breakages.

Under normal conditions so great variations of speed seldom occur. The best pump-building firms generally obtain pump diagrams admitting speed variations down to —3 per cent. Special precautions must be taken under certain difficult working conditions as, for example, if heavy electrical winding or hauling machines, reversible rolling mills, etc., run parallel with the pump motors in the same system without any artificial regulation. One such precaution is a great surplus of head in the characteristic curve itself, the convexity of this curve being especially high. Such diagrams, however, require the use of special impellers, which have another peculiarity in that they do not force the water as high per stage as normal impellers. Another precaution may be found in introducing a throttling valve into the delivery pipe so that the zero point of the counter-pressure curve lies considerably lower than that of the characteristic curve or the point of normal delivery. Either bad economy or many stages (that is, high first cost) must then be taken into the bargain. It must be acknowledged that for work in situations where large variations of tension in direct current, or of periods in alternating current, are permanently unavoidable, tubo-pumps should not generally be selected.

Returning once more to the diagram Figure 40 A, we may easily see that pumps with diagrams of such form would create intolerable operating conditions in the case of large speed variations; for having once snapped off, these pumps still can not furnish a zero pressure higher than the static counter-pressure even after the normal speed of revolution is regained. Here again a part of the delivery pipe must be emptied. As it is generally a characteristic of these large speed variations that they occur periodically, another drop in the number of revolutions may cause the pump to snap off again immediately after it has been brought up to delivery with so much trouble. This hint will serve further to show that the form of the characteristic curve is of the utmost importance. It is true that such pumps, although they are generally inferior also hydraulically, nevertheless by the selection of suitable impeller diameters may be made to work to



The Engineering Magazine

FIG. 41. COMBINED PRESSURE AND COUNTER-PRESSURE DIAGRAM FOR WATERWORKS TURBINE PUMP PLANT.
Three-phase alternating-current motor, 50 cycles.

quite acceptable mechanical efficiency. The form of their characteristic curve, however, betrays them as difficult in operation, at least for the purposes of mine drainage.

For other working conditions, however, these speed variations are quite harmless. This may be illustrated by the example of a waterworks plant. Figure 41 shows the combination of a waterworks counter-pressure diagram with the diagram shown in Figure 35. The base of the counter-pressure diagram here appears much altered. Let us suppose conditions quite usual with municipal water supplies—that is, that water is to be raised from a distant place to a reservoir within the town. The static head may be very small, perhaps even negative if the level of the pumping plant is higher than the reservoir. The counter-pressure results almost wholly from frictional resistance in a long conduit. This, of course, shows again as a pure parabola in the counter-pressure diagram. The point P, where this parabola crosses the characteristic curve of the pump, indicates the delivery and head when the discharge valve is wide open.

Calculation of resistance in long conduits is extremely difficult because the small errors of experimental coefficients become very important by the multiplication corresponding to the great lengths. Differences equaling one atmosphere of pressure or more may be found if the conduit is a mile or two in length. The counter-pressure can be exactly determined only when the resistance of the conduit is known by gauge readings obtained from pumps already delivering through the same conduit. If such indications are not obtainable, there remains only the uneconomical possibility of throttle regulation if, unfortunately, a motor of insufficient power should be chosen. Speed variations of the driving motors, however, are almost without influence upon the volume of delivery, as shown by the dotted parallel curves on the diagram. Snapping off is not to be feared.

INDUSTRIAL USES OF REINFORCED CONCRETE.

By M. M. Sloan.

IV. ADAPTATIONS TO STACKS, TUNNELS AND SPECIAL EQUIPMENT.

Mr. Sloan concludes here his series which began in our January issue. It has considered, in concise, practical manner, many important matters involved in reinforced-concrete construction, including general types and special details of industrial buildings and their accessories.—THE EDITORS.

THE uses to which reinforced concrete may be applied in the construction and equipment of power houses and mechanical plants are numerous. Particularly is it of use in the construction of foundations for heavy engines and generators, and in stacks and the flues connections to them. Besides it is much used in the construction of pipe tunnels and conduits.

Some of the largest stacks or chimneys have been erected of reinforced concrete, and while in several instances reinforced-concrete stacks have not been entirely successful, and one or two failures have occured, there are a number of notable examples which seem to give entire satisfaction. It is usual in the construction of reinforced-concrete chimneys to adopt a typical design as shown in Figure 19. The peculiarity of this design over other chimneys exists in the verticality of the sides and the alteration in the diameter of the chimney in the lower and upper portions. The reason for this is the method employed in the construction. There is some difficulty with a sectional form to cast a concrete chimney tapering from the base to the top, it having been considered more economical and more practical to have a form of uniform diameter. As it is desirable in all chimneys to provide them for a portion of the height with an inner and independent shell, it is also necessary to arrange for this shell by increasing the diameter of the stack at the bottom section. Consequently the necessity for the enlargement of the stack in the base and lower section is apparent.

The shells of reinforced-concrete stacks are made a minimum thickness of 4 to 6 inches and are reinforced with steel rings or hoops and with vertical rods or bars wired or clipped to them.

When the stack is made of the design illustrated in Figure 19 it is evident that the construction where the stack changes diameter must be carefully considered so that there is ample shearing resistance at this point, and the design usually adopted is that shown in Figure 20. It is quite common practise to attempt some architectural treatment for the top of the stack, in the way of a moulded top with bell-cast and fillet as shown in Figure 19.

The place most liable to develop weakness in a stack is at the opening into the stack made for the flue. The design of the stack at this point should be carefully worked out, and the proportion of the flue opening should be such that its width is not greater than one-third of the diameter of the stack. As with openings in any shell, the flue openings should be well reinforced around the edge and over the top so that there is no possible danger of the failure of the stack due to the bending moment of the wind action at the point of its maximum intensity, which is usually at the flue opening.

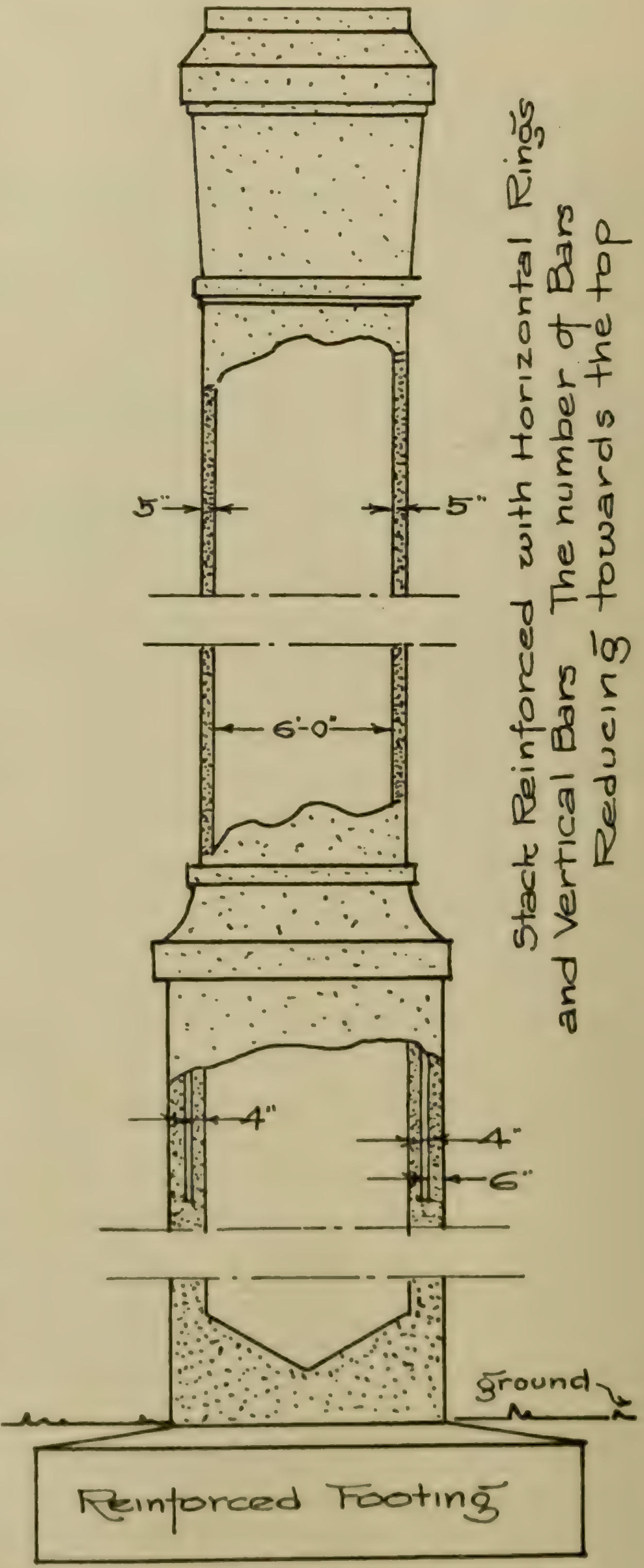

Stack Reinforced with Horizontal Rings
and Vertical Bars The number of Bars
Reducing towards the top
5"
5"
6'-0"
4"
4"
6"
Ground
Reinforced Footing

FIG. 19. REINFORCED CONCRETE STACK.

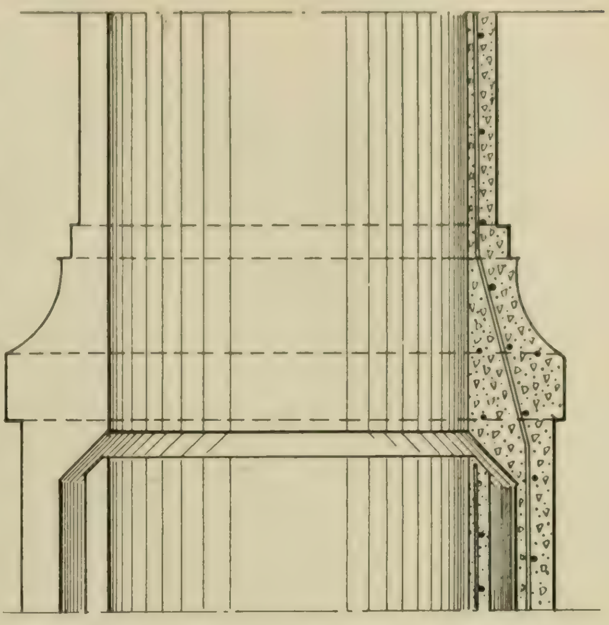


FIG. 20. CONSTRUCTION WHERE STACK CHANGES DIAMETER.

In the construction of reinforced-concrete stacks, a reinforced concrete spread footing is arranged for their support. As the footing must act monolithically with the stack, reinforcing rods are interlaced with the reinforcing rods of the base and carried up into the shell of the stack as shown in Figure 21. One of the most recently constructed concrete chimneys is illustrated in Figure 23, the peculiarity of this chimney consists in the fact that it is based upon a new principle of construction. This principle consists in using forms of such a type that the chimney, instead of having a straight cylinder, is tapered uniformly from the bottom to the top. A chimney constructed in this manner is more economical in the use of steel rein-

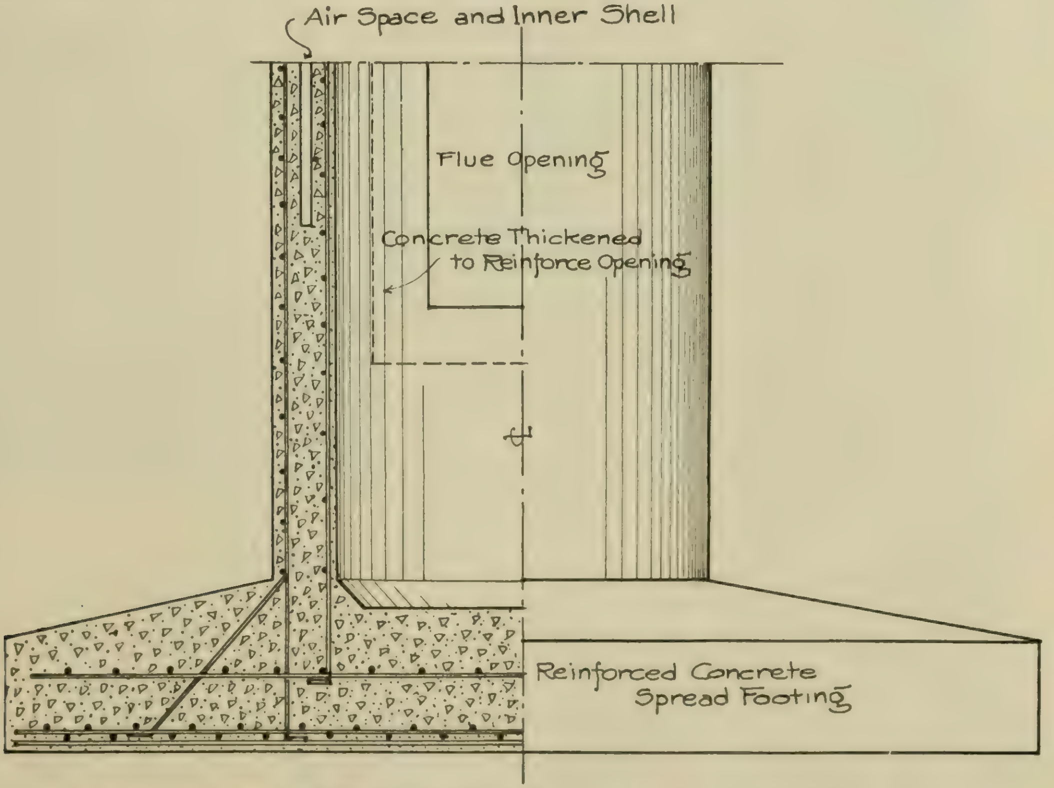

Air Space and Inner Shell
Flue Opening
Concrete Thickened to Reinforce Opening
Reinforced Concrete Spread Footing

FIG. 21. SPREAD FOOTING AND INTERLACEMENT OF REINFORCING RODS.

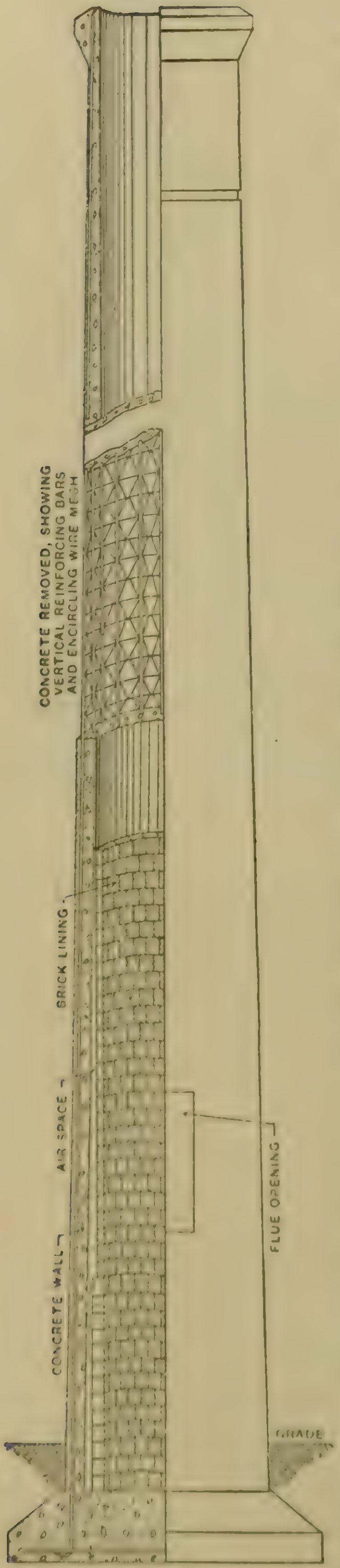

CONCRETE REMOVED, SHOWING VERTICAL REINFORCING BARS AND ENCIRCLING WIRE MESH
BRICK LINING
AIR SPACE
CONCRETE WALL
FLUE OPENING
GRADE

FIG. 22. REINFORCEMENT TO RESIST THERMAL STRESS.

forcement and has greater stability besides giving a better appearance. The design of a stack of this type is shown in Figure 22. As will be observed from this illustration, the chimney is provided with a brick lining and air space. The reinforcement to resist thermal stress is in the form of wire mesh diagonal type.

An unusual departure in the construction of tapered reinforced-concrete chimneys is in the use of a wet concrete mixture instead of a dry concrete mixture. This insures in the finished chimney a better uniting of the concrete and less likelihood to crazing or cracking. One of the most serious objections to the use of reinforced-concrete chimneys consists in the fact that cement, when subject to intense heat, is dehydrated and the concrete upon examination shows a deterioration of the inner surface, of from one-fourth to one-half an inch. How far this deterioration is apt to continue is problematic, and can only be determined by years of experience.

Reinforced concrete is frequently used in the construction of the base for hollow-tile or brick stacks and a very excellent design for such a base is shown in Figure 24. By the adoption of a base of this kind, ample strength is provided around the flue opening. Sometimes the reinforced-concrete base is lined on the inside with firebrick or hollow tile, and it is in all instances well reinforced both with longitudinal and horizontal rods as illustrated in the figure.

It is quite the usual practise in the planning of eleemosynary institutions to arrange for a central power plant in a separate building, distinct from the others of the group. This is necessitated by the desirability of avoiding the noise or vibration, the dust and danger incidental to a power plant, affecting the administration and the inmates. There-

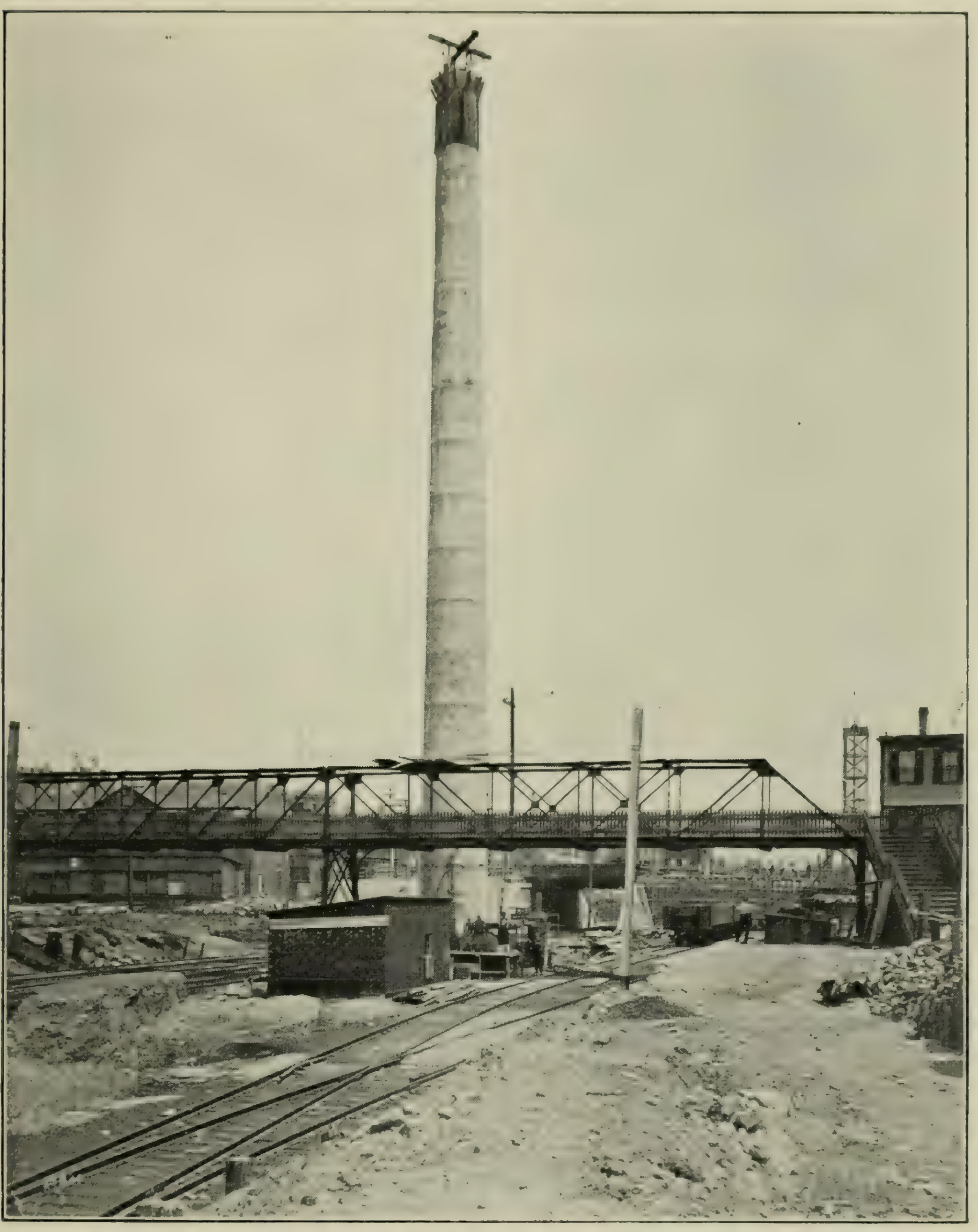


FIG. 23. REINFORCED-CONCRETE CHIMNEY WITH UNIFORM TAPER.

fore it becomes necessary to provide a means of carrying the wires and pipes from such a plant to the several buildings. This is generally done by means of a tunnel, and this is best constructed of reinforced concrete in the manner shown in Figure 25. The greatest difficulty in tunnel work of this character is due to the fact that the tunnel is quite likely to run through a wet soil, or at some point throughout its length it will pass through a natural drainage basin. It is very difficult to make a tunnel of this character water-

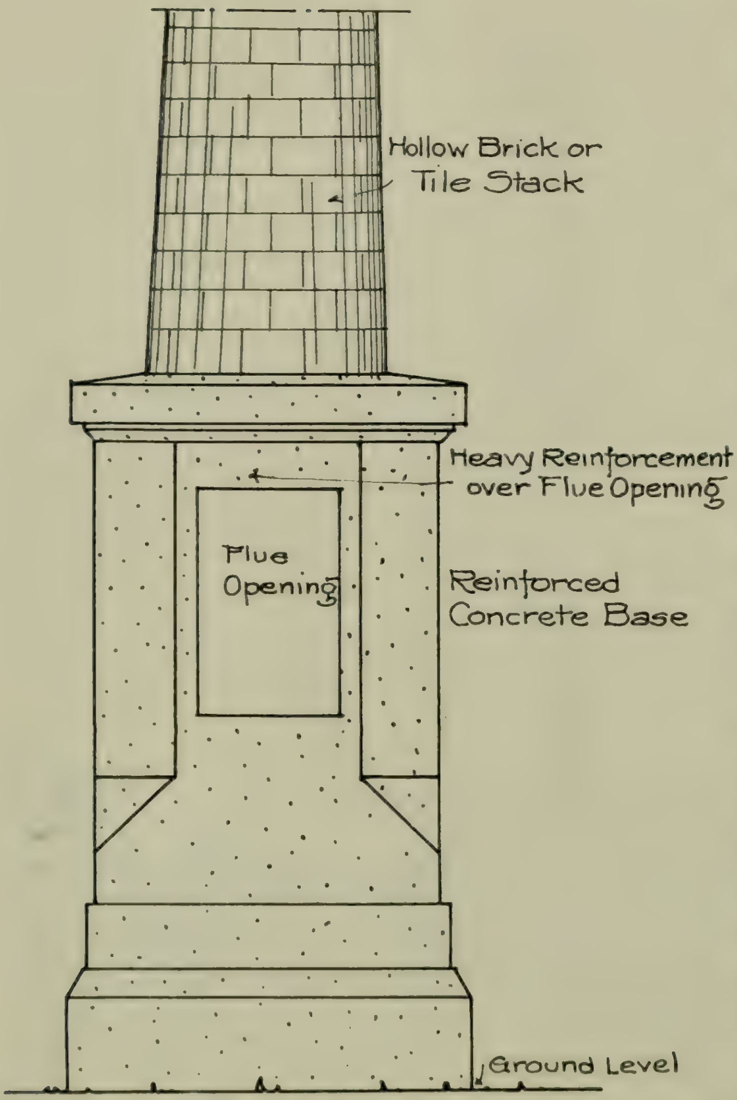

Hollow Brick or Tile Stack
Heavy Reinforcement over Flue Opening
Flue Opening
Reinforced Concrete Base
Ground Level

FIG. 24. BASE FOR REINFORCED-CONCRETE STACK.

proof, so that it is best constructed with French drains on the sides so as to intercept any water that may flow through the strata of the soil. In order to provide for any possible leakage through the walls of the tunnel, the floor of the tunnel should be conveniently arranged with gutters on either side as at "a." There is a considerable amount of surface water which should be taken care of by sloping the top of the tunnel as shown at "b" and arranging for it to drip into the French drain. The concrete walls of the tunnel are amply strong if made about 6 inches in thickness, and should be reinforced with longitudinal and vertical reinforcing rods as shown in the figure.

Ordinarily, plain concrete is used in the construction of engine and generator foundations and power houses. There are, however, conditions encountered in the construction of mechanical plants which necessitate the use of reinforced-concrete construction.

It quite frequently happens, especially in old buildings where new units are to be installed, that the engine foundation is quite close to the wall of the building. In Figure 26 is illustrated a reinforced-concrete engine-foundation construction, which was advantageously used where the conditions were unusual. The soil in this particular instance was so poor that it was necessary for concrete piles to be driven in order to support the engine foundation. It is not possible with ordinary means to drive concrete piles close to a building wall—that is, the centre of the pile must be about 3 feet from the face of the wall. It is evident from Figure 26 that the pile "a" cannot be centered under the outboard bearing. Consequently the engine foundation must be made of reinforced concrete and the depth of concrete beneath the flywheel pit must, when reinforced with the rods or bars "b," have sufficient resistence to carry the cantilever supporting the outboard bearing with its load. As the foundation is in the nature of a cantilever, it is advisable to run anchor rods or bars down into the concrete piles and up into the engine foundation so as to interlace with the reinforcing rods of the cantilever beam. While this type of construction is not recommended, it is the most convenient and available means of constructing a large engine foundation to meet the peculiar conditions existing in this instance. There are several examples of heavy engines running successfully and retaining their alignment on foundations constructed in this manner.

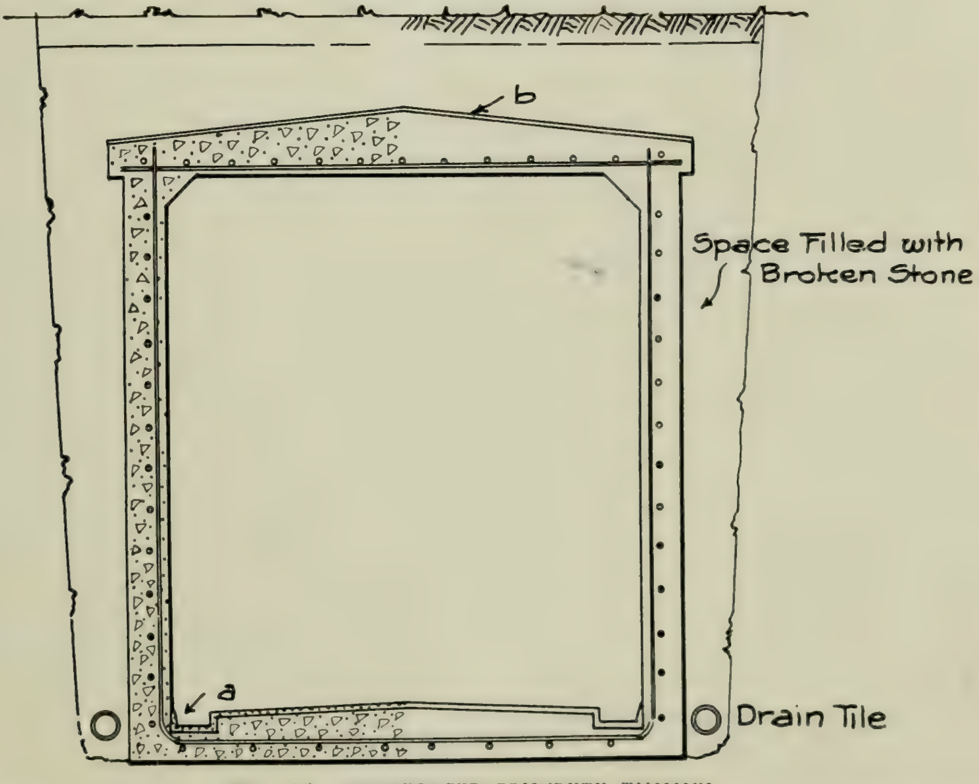


FIG. 25. REINFORCED-CONCRETE TUNNEL.

In a reinforced-concrete building where a belt drive is used from a heavy engine it is customary to provide a reinforced-concrete floor or roof over the engine room. This is the best possible construction because it not only provides an ample protection against fire over the "heart" of the plant, but it also furnishes a rigid construction to which the hangers for the head shaft can be attached.

Where the hangers for the head shaft are secured to reinforced-concrete beams or girders, it is best to use some other means of fastening than the usual sockets. Generally the best practice is to provide pipe sleeves through the concrete, and use "through bolts" with heavy plate washers.

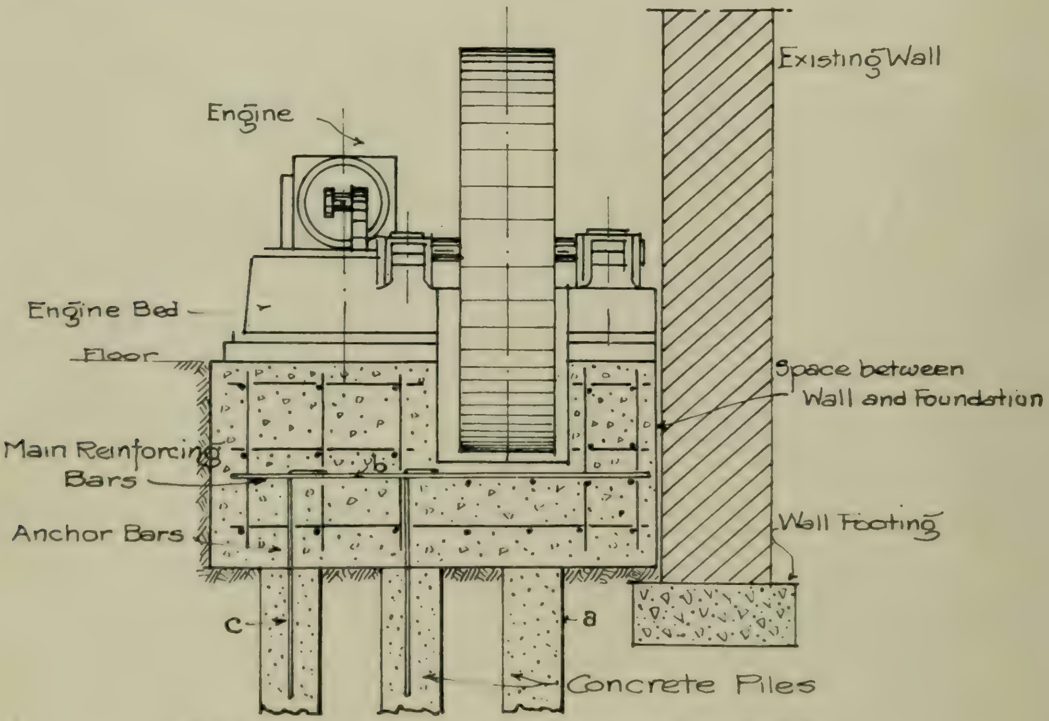


FIG. 26. REINFORCED-CONCRETE ENGINE FOUNDATION.

Reinforced concrete is also extensively employed in power-house construction work, in the construction of coal bunkers and storage bins and also in concrete tanks and reservoirs; as well as hot wells and sump wells. These are usually well reinforced and are generally made waterproof by mixing, in the mass of the concrete or in the surface finish, a waterproofing compound. In the better class of work, a surer means of waterproofing is employed such as a diaphragm of asphalt with a protecting lining.

In all instances, it is advisable where possible to take the additional precaution for making the walls of the tank or reservoir waterproof by puddling the back of the walls with clay.

Reinforced-concrete construction has advanced to a place of importance in power-house work and is used more extensively to supplant other types of construction, for foundations of machinery of a building as well as in the auxiliary appliances such as coal bins, ash tunnels, and hoppers which are of such importance in modern power-house work.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

VII. COSTS IN RELATION TO THE FINANCIAL BOOKS.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," the third to "The Elements of the Land Factor," the fourth to "Buildings, Heating and Ventilation, Stores, and Organisation," the fifth to "Apportioning Indirect Expense by Production Factors," and the sixth to "Control Accounts." The present installment concludes the argument.—THE EDITORS.

THE final court of appeal in all factory accounting is, or should be, the financial books, which bring their record of operations to a focus in three final accounts—the Trading Account, the Profit and Loss Account, and the Revenue Account. Manufacturing costs, whether interlocked with the financial books or treated as entirely separate and subsidiary, should be regarded as an attempt to present an amplification and detailed explanation of the condensed figures set out in these final accounts.

Generally speaking, these accounts deal with three different aspects of profit, viz ;— (1) gross manufacturing profit, (2) net trading profit, and (3) disposal of profit in dividends, etc. These accounts are sometimes called by other names, as for instance, Manufacturing, Trading, and Profit and Loss, instead of Trading, Profit and Loss, and Revenue; but however styled, the functions of the three final accounts are, generally speaking, substantially as above stated.

The three specimen accounts given will serve to show the usual scope of each. In the first one it will be seen that by setting the value of stores and work in hand at the end of the financial period against their value at the beginning of the period, plus the amount of stores purchased and wages paid, we virtually ascertain how much the total value in hand has increased or diminished since the last stock-taking. It will usually be found to have diminished by reason of deliveries effected, and it will be obvious that if we were to credit the account

Dr.	Trading Account		Cr.
Work in Hand at beginning of period	$ 10 000.00	Work in Hand at end of period	$ 10 426.00
Stores " " " " " "	3 000.00	Stores " " " " " "	2 891.00
Purchases during period	2 876.00	Sales during period	25 103.00
Wages paid during period	11 813.00		
Balance = Gross Profit for period	10 731.00		
	$ 38 420.00		$ 38 420.00

Dr.	Profit & Loss Account		Cr.
Repairs & Maintenance	$ 400.00	→Gross Profit from Trading A/c.	$ 10 731.00
Interest & Depreciation	1 020.00	Discounts taken	50.00
Rents, Taxes & Insurance	130.00		
Management & Supervision	300.00		
Office & Selling Expenses	2 300.00		
Packing & Freight	400.00		
Discounts allowed	50.00		
Balance = Net Profit for period	6 181.00		
	$ 10 781.00		$ 10 781.00

Dr.	Revenue Account		Cr.
Interest on loan Capital	$ 1 290.00	→Net Profit from P.& L. A/c	$ 6 181.00
Legal Expenses	121.00		
Directors Fees	200.00		
Reserve Fund	1 600.00		
Dividend for Period	2 970.00		
	$ 6 181.00		$ 6 181.00

The Engineering Magazine

In engineering works, additions to plant and repairs to tools, buildings and plant are frequently carried out by the shops. In such cases the value of the work would be credited to trading account. In the accounts above and in the discussion following it is assumed for simplicity that a purely manufacturing business is done in the shops, repairs, etc., being contracted for with other firms. The figures given are purely illustrative and do not represent any actual case.

with the *cost* value of such delivered orders, it would exactly balance, and show neither profit nor loss. As, however, the account is credited at *sale* prices it follows that a balance corresponding to the difference between cost and sale price—that is, to gross profit, will appear.

In the second account, the gross profit transferred from the previous account is subject to a process of diminution by setting against it the indirect charges or establishment expenditure, some of which are really costs of production and some are charges arising from selling and distributing the product. The long established practice of collecting all these into the same account has given rise to much of the confusion that surrounds the question of charges, especially in the matter of distinguishing between shop and general charges. The third account deals only with the disposal of profit and not with how it was made. It does not need further consideration at the present moment.

The reason why Trading account is arranged as it is will be clear when we remember that very few auditors have any faith in the apportionment or distribution of charges, and prefer to deal with figures which have the merit of being definite, as the direct expenditure on wages and materials usually is, and to set against these the equally definite figure of sales—the difference between the two representing, it is true, no complete fact, but giving, nevertheless, a relation of well understood significance, viz:—gross profit.

It should be observed, that for financial purposes it is not necessary to have any knowledge of what are usually known as costs. It is sufficient to know the sale price of each order, and when all these are aggregated, forming a total of sales for the period, the difference between values in hand at the beginning of the period and the values in hand at the end of the period (plus what has been put in during the period) gives a net figure which is really equivalent to *the prime cost of all the orders in a lump sum.*

To ascertain profits, therefore, it is not necessary to know individual costs, but only individual sale prices, if a stock-taking valuation is taken at the beginning (or end) of each financial period. This ascertainment of results in the lump at the end of a year or half year is still relied on by many firms.

But just as the figure representing total sales is an aggregation of a number of individual sales, so the balance representing cost of orders is really an aggregate of a number of individual costs. If therefore an accurate system of prime costs is in use, the trading account could be very simply checked by making a list of all orders which have been completed and invoiced and placing the prime cost against each. It is clear that this list, if set against a list of the sale prices, would show a difference that would be identical with the gross profit exhibited by the trading account.

In the same way, if a perfect system of distributing all the indirect charges incurred in production were in use, and a list were to be prepared of all delivered orders showing:—

1.—Their prime cost . . . wages and materials.

2.—The indirect shop charges.

3.—A due proportion of general and selling expense, then the aggregate of these items for all orders completed and delivered, when set against the sale prices, would show a difference or balance exactly corresponding to the net profit shown by the profit and loss account.

We are now in a position to realise what an entirely different procedure is commonly undertaken with regard to presenting the details of these two great divisions of manufacturing cost represented respectively by these two accounts. No one has ever suggested that prime costs should be averaged. No one ever argues that if $200 has been spent on $20 articles, then the cost of each can be safely considered at $10, unless indeed the product is absolutely uniform. Such a suggestion would be treated with ridicule, because obviously the only use of detailed costs is to reveal the *relative* amounts of wages and material that the different orders have absorbed. The incidence of labour-cost and material-cost on orders is too obviously individual and unequal for us to think of averaging prime costs.

When, however, we come to the second and third elements of cost, which form the subject-matter of the profit and loss account, an entirely different plan is commonly pursued. Notwithstanding that the expenditure under this head frequently equals and sometimes surpasses in value the item of wages which are generally so carefully traced and allocated to individual orders, it is a very usual practice to average this large class of expense, and to express its incidence by a simple percentage either upon wages or upon time.

That this plan is entirely misleading there can be very little doubt, because few of the expenses in the profit and loss account have any relation either to each other or to wages or to time. To rely upon an arbitrary established percentage which may actually be either much over, or much under, the real incidence of a number of varied factors on a particular order, may be a good way of getting rid of figures and giving an air of finality to cost accounts, but it is very little else. As a guide to actual profitableness of particular classes of work it is valueless and even dangerous.

If, however, the greater part of indirect expense could be reduced to a *real* incidence on particular jobs, we should find ourselves at once in presence of new and important classes of facts. Foremost amongst these is the question of inefficiency due to idle manufacturing facilities, or as I prefer to call them, "Production Centres." Whether such production centre be a machine, a pattern maker's bench, or a plain floor area in an erecting shop or a foundry, it is obvious that if it be idle and unoccupied in production, money value is as surely being wasted as if wages were being paid to a number of men who were entirely unoccupied. To allow the incidence of such wasted resources to become attached to work by means of an averaged percentage, on whatever basis the latter is calculated, is grotesque in its inadequacy to represent actual facts.

Nor is it less absurd to include selling expense in the same percentage with manufacturing expense. The two have no relation to one another whatever. The routine, the methods of selling, and the expenditure on different classes of articles may and often do vary considerably. It may easily happen that the efforts and the expenditure to obtain business in particular lines are so great that the result is not by any means worth the trouble. How is this important fact realised by any plan of averaged percentages? If such facts, and those just referred to (idle production centres) are not brought out separately and distinctly, it may well be asked,—what is the use of an averaged percentage at all? The answer is that in certain very limited conditions it is of value, but that where more than one class of article is being manufactured it becomes merely a remarkably intricate device to give misleading information.

The proper relation of costs to the trading account and the profit and loss account may now be summed up. These two accounts give results *in bulk*. Prime costs are the details of labour and materials on the individual orders, which have passed out of trading account by reason of sales. Complete costs *should be* the prime cost plus the accurately detailed incidence of shop charges, general charges and selling expense, also on each individual order. Manufacturing cost plus selling cost should, then, contain several separately expressed factors as follows:—

1.—Prime cost . . . wages and materials.

2.—Shop burden, which will include a proportion of general or administrative expenses.

3.—An inefficiency factor, or supplementary rate, representing loss of efficiency due to idle production centres and wasted facilities of manufacturing.

4.—Selling expense (also including a proportion of general or administrative expense) based on the actual absorption by each *class* of product, of the different items of selling expense.

It will probably be objected that this is a very complex and formidable way of presenting costs. The answer is that in actual practice it is not as difficult as it looks, but a still more complete reply to the objection is that no method that fails to provide the information in this detailed form is anything more than a sham. *No facts that are in themselves complex can be represented in fewer elements than they naturally posses.* While it is not denied that many exceedingly complex methods are in use that yield no good results, it must still be recognized that there is a minimum of possible simplicity that cannot be reduced without destroying the value of the whole fabric. The snare of the "simple system" is responsible for more inefficiency and loss than is generally realised.

Work accountants would be better able to realise this point of view and enforce it on those to whom it is a matter of importance, if, instead of collecting all items of indirect expense into profit and loss account, they were to divide the latter into two accounts, thus providing an intermediate account between gross profit and net profit. (See specimens opposite). In such case trading account would contain prime cost only; the new account, which might be called net manufacturing account for want of a better title, would correspond with elements (2) and (3) of cost, while profit and loss account would correspond with element (4). The items given in the specimen accounts will explain this disposition, the only special point being the division of general and administrative expense between the shops and the selling department on an adequately thought out basis.

Arranged in this way the place and position of each of the elements of cost in relation to the final accounts is clearly seen, and also the utter inadequacy of "simple systems" to represent all these different factors. It may even be said that a measure of the success of any system of collecting costs is thus provided, because complete agreement with these accounts at each stage must be insisted on as a means of verifying the accuracy of cost figures.

SELLING EXPENSE.

The true relation of selling expense to production can be grasped most effectually by picturing the works and the selling department as being located in different places. With the former in the country and the latter in a more or less distant city the relation is at once seen to be perfectly simple—namely, that there is no relation at all! From this consideration it is not very difficult to realise that the mere fact of their happening to be located in the same place or in near neighbourhood does not make their mutual relations any more intimate.

It is the more important that this fact be fully realised since the types of selling organisation are far more varied than those of manufacturing organisation. Even in the same concern some of the product may be on an entirely different footing as regards selling expense from other items. For example, a large section of the business may

TRADING ACCOUNT

Dr.			Cr.
Work in Hand at beginning of period	$ 10 000.00	Work in Hand at end of period	$ 10 426.00
Stores " " " " " "	3 000.00	Stores " " " " " "	2 891.00
Purchases during period	2 876.00	Sales during period	25 103.00
Wages paid during period	11 813.00		
BALANCE = Gross Profit for period	10 731.00		
	$ 38 420.00		$ 38 420.00

NET MANUFACTURING ACCOUNT

Dr.				Cr.
Indirect Expense in Shops	Interest, Depreciation, in Shops	$ 930.00	→Gross Profit from Trading A/c.	$ 10 731.00
	Repairs & Maintenance in do.	350.00		
	Rents, Taxes & Insurance in do.	96.00		
	Other Shop Expenditure	100.00		
	Proportion of Administration Expense*	306.00		
	BALANCE = Net Manufactoring Profit	8 949.00		
		$ 10 731.00		$ 10 731.00

PROFIT & LOSS ACCOUNT

Dr.				Cr.
Selling Expense	Travellers & outside staff	$ 1 160.00	→Net Manufacturing Profit	$ 8 949.00
	Advertising, Catalogues &c	400.00	Discounts Taken	50.00
	Packing & Freight	400.00		
	Sales Dep't staff	600.00		
	Discounts allowed	50.00		
	Proportion of Administration Expense*	208.00		
	BALANCE = Net Profit	6 181.00		
		$ 8 999.00		$ 8 999.00

REVENUE ACCOUNT

Dr.			Cr.
Interest on loan Capital	$ 1 290.00	→Net Profit from P.& L. A/c.	$ 6 181.00
Legal Expenses	121.00		
Directors Fees	200.00		
Reserve Fund	1 600.00		
Dividend for Period	2 970.00		
	$ 6 181.00		$ 6 181.00

The Engineering Magazine

Administration expenses consist of office rents, staff salaries, management expenses, and similar items common to the manufacturing and selling departments and not separately allotable to either. Compare these accounts with those on page 78.

consist of a standard product for which there is a steady demand, arising from the reputation of the firm for that product, and requiring no special and expensive efforts to secure business. Another portion may consist of a specialty, recently introduced, and taking a large amount of time, attention, advertising and demonstrating expense, installations on appproval, etc., to effect sales.

It will be evident that any method of dealing with selling expense must distinguish between these two classes of sales, and not average the total selling expense over total sales. In other words, selling expense must be dealt with by classification of product, having in view, not the difference in cost of manufacture but difference in calls on the expenditure of the sales department. All product should be debited to the sales department at works cost—what happens thereafter is no concern of the productive departments, and the figures relating to the two classes of activity should never be mingled. The principle of "keeping separate" is as important here as in all other branches of technical accounting.

As these articles are intended to deal only with production, the question of selling expense cannot be further enlarged upon, the subject being a large one and deserving separate treatment. It will be sufficient for our present purpose to emphasise the principle that production expense ends at the works gate. In the sample accounts presented here, it will be observed that selling expense is groupd by itself in the profit and loss account. This is as it should be, because it represents a wholly different class of activities which require to be dealt with on their merits. Manufacturing and selling call for the exercise of quite different faculties, rarely found combined in the same individuals.

SUMMARY OF THE PRODUCTION FACTOR METHOD.

The method of organisation by production factors and their connection with production centres has now been outlined. We have seen how a considerable number of items hitherto considered as indirect or floating charges are really possible of consideration as in the nature of rents chargeable against production centeres, and thence passing out onto the work performed by those centres. We have seen that production is made up of services, of which labour is only one. And we have also seen that inefficiency due to slack production can be expressed as a separate factor of cost. Further, we have seen that selling expense is not reducible to the same basis as production, but that it has laws of its own that cannot be neglected.

It will be obvious that costs developed on this plan are a more subtle engine of discrimination than any hitherto available. The production-factor method gives free and independent play to the various elements of cost in a manner that is not possible of realisation on any method that first drags heterogeneous expenditure forcibly into lump sums, and then deals with these as if the only object were to get rid of them on work—no matter how, as long as they are got rid of. On the contrary, we have seen that each production centre bears its own burden, and pays its own series of rents quite irrespective of what its neighbour is bearing, and this without reference to whether the shop is slack or busy. Further, the effect of waste of factors, as for instance a shop only half full of tools, or in which tools are unnecessarily and wastefully isolated, shows itself as a separate element of cost, or rather it goes to swell the supplementary rate which is to a considerable extent an inefficiency element of cost.

The control over the form of costs obtained under the system of organisation by production factors, though important, is not the only, or perhaps even the greatest, benefit attained by this method. The point of view from which production necessarily becomes regarded is an even more important matter. A clearer insight into what manufacturing really implies is gained when we begin to look at a works or factory as an assembly of centres each absorbing special services or "production factors" independently and unequally. We come to regard a machine, not as a mere inert piece of ironmongery but as a kind of living entity having as nearly definite a price as the work of an operative has a definite price. This price moreover is no arbitrary one, but is compounded of a number of separate and independent factors, which it is possible under certain circumstances to vary and reduce.

The modern plan of laying out everything as far as possible in advance, of predetermining results, and of rigorously comparing what has taken place with what was expected to take place, has a close relation to this form of organisation. Until the idea of planning became familiar, the idea of mapping out the activity of a complex factory in definite production centres would have seemed impossible of attainment. And it is equally true that this method of organisation reacts in no feeble way on the possibility of predetermined results of actual manufacture, since it permits every extension and every rearrangement to be reduced in advance to figures—definite, not as affecting particular groupings of indirect charges, but as bearing on the hourly work of every single machine or production centre.

The most noticeable tendency in engineering manufacture at the present time is a desire to reduce all operations to definite standards. "The machine-shop problem" as Charles Day said recently in these pages* "in its most elementary sense, resolves itself into one of removing chips from the parts on which work is to be done." And in this direction "shop practice is nearing a stage approaching standardisation," largely because "the records that have been secured and the standards that have been established by machine-tool builders and the concerns manufacturing tool steel are now so complete that their maximum capabilities can be foretold within reasonable limits."

These developments are part of the general progress towards regarding manufacture as a step by step series of definite predeterminable operations—a tendency that cannot be fully realised until the vague incidence of indirect charges is, once for all, got rid of and the maximum and minimum range of incidence on definite production centres substituted for it. When along with the "chip-removing" capacity and power absorbtion of every different type of machine we begin to realise that it has a natural machine rate, which can be forecast within certain limits even before it is actually installed in a shop, a good step forward will have been made in the direction of final standardisation. Only the accumulation of records and of compared experience can make this possible, but it will be allowed that *a general acceptance of the principle of organisation by production factors would have the effect of making known the usual or standard values of such factors under conditions of good practice,* and that therefore as soon as the elements of cost, power, durability, space, and attendance of any new machine were determined, *its normal rate under conditions of efficient and economical installation and working would also be predeterminable with sufficiently close accuracy.* In so far as such theoretical rates were not realised in actual practice it would suggest a prima-facie case for enquiry into causes.

It may be objected that these factors are subject to change. That is their merit. The belief in the possibility of a simple system, that once established, will give accurate results for all time, is based on sheer inappreciation of the problem. In a works undergoing changes and modifications the actual factors of production are constantly being varied, *whether we wilfully shut our eyes to the fact or not.* The merit of the production-factor system is that it provides a method of quickly taking note of such changes and allowing their influence to become manifest, instead of ignoring them, and dwelling in the false security that changes of manufacturing method have not shifted the incidence of factory burden. Every such change does so, and just how far and what direction it works is a very important matter.

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*"Machine Tool Practice for Maximum Production," in THE ENGINEERING MAGAZINE for July, 1909.

When someone unfamiliar with manufacturing is taken into a machine shop, his impression is that of a wonderful activity of which he can discern neither the plan nor the guiding strings. Those having an inside knowledge based on older methods of organisation are not as much advanced beyond this point of view as might be imagined. The shop presents itself to them as a number of machines and a number of men, it is true, but they can only picture a very limited portion of the total activity as definitely connected with work performed. This portion is represented by the hourly wages of men actually engaged on orders; all the rest of the activity and all the rest of the expenditure, seen and unseen, is blurred into a vague and indefinite perception and lost in the mists of "indirect expense." The narrowing down of indirect expense to close association with production centres is therefore not only important from the point of view of costs, but promotes clearer ideas of organisation and helps to answer in a very definite way the ever pressing question "where all the money is going to."

As has been alreay referred to in these papers, one of the obstacles to a clear view of the true relation of indirect charges to work has been their *continuous* character. Whether work is being done, or not, the larger portion of such charges have to be met, if not out of profits, then at the expense of capital. Unconsciously the argument is made that if these charges are always pressing on the undertaking whether work is being done or not, then they cannot have any real connection with particular items of work. But *what is really being paid for is the capacity to produce,* and whether that capacity is being wasted or not it still has to be paid for either out of profits on the unwasted portion or out of capital. When, however, we do employ that capacity it seems fairly obvious that the cost of the portion employed passes into the work done as an element of job cost.

In this connection it must never be forgotten that the "Supplementary Rate," the moment it rises above the normal, represents shop inefficiency. It represents that portion of the cost of the job which is due to abnormal conditions. By expressing this amount separately, we disentangle true costs from apparent costs in a way that has never before been possible. In other words, the supplementary rate is closely identified with the continuous character of indirect charges, and it overcomes the obstacles to a clear view of their true relation to work just spoken of. The utilised capacity of production centres passes into the ordinary cost of the work, the unutilised or wasted portion flows into the supplementary rate, and becomes a memorandum of the inefficient conditions prevailing. A high supplementary rate represents wasted opportunities and nothing else; its expression as a percentage on work is only a matter of convenience, for the purpose of a danger signal. It consists, in fact, of that portion of the indirect charges which if not dealt with in this way, would remain to the debit of profit and loss account. Either as part of costs or as a balance on the wrong side in the accounts, it signifies unemployed capacity for production. It is distributed over work done only because its significance is more easily recognised in that way than if it were left as an undistributed debit balance. Further, it is thus brought to the notice of officials who have no access to the accounts.

If there is one thing more than another that seems to require emphasising at the conclusion of these articles, it is the need of regarding costs as having an intimate and vital relation to the financial accounts. The requirements of accountants and of technical officials differ so much that each is apt to go to his own way and pay little attention to the other's work. As a matter of fact, costs can be more intelligently understood, particularly as regards their relations with indirect charges, if they are regarded as the separate items from which the financial accounts are built up. To speak technically, the latter are the control accounts and the former are the detail accounts which ought to correspond completely and absolutely. The doctrine of unemployed capacity set out above has been developed not from the shop side, but from a review of the elements of profit and loss. During this examination it was observed that where charges due to the activity of production centres were alone made part of costs, a considerable balance remained if the shops were not employed to their full capacity. That this balance represented wasted capacity of production *and was in fact the price paid for that waste* was presently seen. This instance is given to show how pure accountancy can be made to throw light on manufacturing problems, for it is certain that a study of costs as costs would never have brought this important fact to light.

Lastly, emphasis must be laid on the fact that there can be no such thing as "simple" systems of cost. There cannot be less than five elements in any true cost, all of which must be expressed separately. (1) Materials; (2) Direct Labour; (3) Machine Rate (which expresses in one figure a number of different and independent incidences); (4) Supplementary Rate, expressing wasted or unemployed capacity; (5) Selling Expense. It is hoped that the arguments put forward in these articles will have served to demonstrate that these five elements have no common ground and cannot therefore be expressed in any other way than quite independently of each other. Any other method must produce figures that are necessarily unreliable, and unsafe.

IRREGULARITIES IN FURNACE FIRES.

By Arthur S. Mann.

Mr. Mann offers and supports by argument a suggestion which has recently come from several independent sources—the suggestion that competent technical men be placed in direct and immediate charge of the fireroom and its stokers. It is an interesting proposition, and one that our contributor is in position to discuss with authority.—The Editors.

A FIRE bed is seldom homogeneous. Therefore heat coming from different parts of the fire is not uniform, and the furnace gases must differ in composition for a part of their path toward the breeching. There is indeed no certainty that they ever become uniform in composition.

A large bed of fire, say 10 feet by 8 feet, worked and stoked by hand, depends for its uniformity upon the watchfulness of the fireman. He cannot change the coal, and he can do no better than to see that the fire bed has a thickness approximately even.

The coal itself is a variable. When a sample for analysis is desired, small portions are taken from the car or the storage, pounded up, mixed, and quartered till a workable sample is secured which is representative. The fireman cannot take such pains with his coal. He gets fifteen or twenty pounds on his shovel and throws it into his fire. Volatile matter in excess may and does reach parts already oversupplied, and this is another irregularity added to imperfections in stoking.

Working the fire with bar and rake causes sure and added inequalities, all contributing toward a furnace gas made up not of a uniform mixture, but rather of numerous streams that probably never intermingle. Some time ago a small plant came under my observation. There were two 60 horse-power boilers fed with a single direct-acting pump. The load was steady and the speed of the feed pump could be kept constant throughout the day. The feed valves from the main to each of the boilers were stuck fast from disuse. If the water was a little low in one gauge glass, a barring was given the other fire which brought the glasses even again; and so the plant see-sawed all day.

Now in the case just cited it took only a slight movement of a bar to lower the water. The fire appeared only slightly different after the barring, and it should be added that the fires themselves were only moderate—quite cool enough to be visible all over. A hole or a thin spot would have been clearly apparent, but a small irregularity would escape unnoticed unless looked for carefully. To be sure, it was not necessary to evaporate the excess water in the boiler showing the high gauge; the boiler had to make only a little more steam than its neighbor, raising its pressure slightly and so offering greater opposition to its incoming feed water.

Another case of this character presented itself in a plant fitted with chain-grate stokers and horizontal water-tube boilers of the Babcock & Wilcox type. The boilers are two-drum, 250 horse-power, with a liberal grate area. The station itself is situated in one of the British colonies and boiler fittings follow British custom. In respect to gauge glasses, each drum has a glass fixed directly to the drum head without water barrels. The boilers themselves were slightly underloaded, about 95 per cent of rating perhaps, and the fires were never forced. The draft was ample and the equipment steamed easily.

It would appear that under the conditions cited the fires would be uniform all over. There is an adjustable gate lying horizontally between the hopper and grate which gives a uniform fuel thickness, and this is set to give a feed proportionate to the load. The soft coal was crushed to 2-inch pieces and smaller, precluding the possibility of a bare spot, and all parts of the fire were subject to the same chimney draft. Despite this apparent uniformity in the fire, the two water gauges in any given boiler seldom showed equal heights of water. Sometimes the difference would be not more than one inch; at others, there would be a variation of nearly 3 inches.

In this instance it is probable that the drum showing the low water had greater steam pressure due to more vigorous combustion on that side. The fires themselves were never touched with a hand tool, so that burning conditions were as uniform as machinery could make them.

A third instance of uneven water occurred in a plant larger than either of the others. The plant itself had been increased by the addition of some five hundred horse-power horizontal water-tube boilers. The furnaces were fitted with a stoker which could carry large overloads. The fuel after once reaching the grate was worked by hand. When the first attempt at forcing these boilers was made, they sent water in large quantities out through the steam pipe. They were all right at regular load and at 30 per cent above load, perhaps. When 60 and 70 per cent overloads were called for the water gave trouble.

These boilers had two horizontal drums. The whole trouble was cured by adding a steam cross pipe in the live-steam connection; but the additional area was required to take care of the excess steam which one side of that fire generated under forcing. Steam velocities were high, but the furnace chamber was not divided in any way. Gas coming from one section of the fire was quite free to mingle with that from other sections. Still the irregularity was very pronounced in development of pressure.

When there are irregularities such as these in a fire; when their presence is known; and when effort is made to improve the defect, and at the same time the imperfections still remain in spite of all available effort, it would appear that like irregularities might exist in a furnace when they were not expected and where no special effort is made to remove the disability. And unless there is a certainty that the furnace gases are thoroughly mixed on their way through the boiler, it would seem impossible to draw conclusions in regard to efficiency of combustion by taking a small sample of gas occasionally from a large thoroughfare. The usual sample is only 100 cubic centimeters. A 500 horse-power boiler gives off 20,000 cubic feet of gas each minute, so that while the volume of sample is being drawn, 3,000,000 like volumes have passed the sampling plant. Without some specially prepared intermixing device, it would seem unlikely that the sample should be even fairly representative, particularly when it is known that the gases start from the furnace with widely different compositions.

It would also appear that if perfect fires are wanted, something better than gas analysis must be the criterion of perfection. There are occasions where a very marked improvement in furnace efficiency is made possible through the use of gas-analysis apparatus, but in such instances it may also be that almost any change in the fire, changing either thickness or air pressure, would have made as great or greater improvement. If efficiency is only low enough to begin with, it is possible to make very liberal improvements. It should be realized that gas analysis is nothing more than a check at best.

I recall acting for the purchaser in some stoker acceptance trials. The inventor of the apparatus was present in his overalls, and he had a very able fireman as assistant. The fireman was fairly busy in caring for the needs of the furnace. The inventor was active in watching the fire itself. He depended upon the way the fire looked, on top and underneath. It was "Jim, just check that draft for a few minutes;" "run your bar down this side;" "give a little more action on that end;" "check that feed a little;" and so it went all day. The two could have cared for more stokers, to be sure, but they both felt that burning coal called for an active head. The actual evaporation was nearly eleven pounds. No attention was paid to the flue-gas analysis. The man managing the fire did not need that sort of a crutch. Some analysis were made, however, for a matter of record. The best examination a fire can have is made with the eye. If the grate is flat something can be learned from a rake and slice bar, but the man who expects to do well in the fireroom must know what a good fire looks like, and he must know a hole when he sees one. He should be something more besides. A good fireman can be taught certain of these matters.

But looking at the fireroom broadly, it is much like a large laboratory, or a chemical factory. The manager of such an establishment does not expect laborers to determine his mixtures, or to pass upon his product. Technical work calls for technical knowledge and the chemistry of the processes is properly organized. Is it to be expected, then, that men knowing nothing of chemistry should be qualified to manage a fire properly with varying fuel; or that they should be able to judge accurately of gas pressures and gas velocities? I recall a number of stations which have been running for some years, with good equipment, and which have been deficient in draft. The firemen are good men of their sort, but suggest no improvements. In another instance a certain percentage of CO_2 was insisted upon with a technical man to collect and analyze samples. The regular fireman managed the fire as he saw fit, provided the CO_2 showed a certain percentage. The boiler trials gave an evaporation of about eight pounds where eleven was possible.

Such a trial is of little value. It tells nothing about the coal, and nothing about the furnace. We do not attempt to judge of the worth of a new harness and a new wagon by hitching up an old worn out horse that is good for only half a load anyway. In order to judge a furnace, and a coal, fires must be as perfect as they can be made. If only 60 per cent of the heat in the coal is turned into the steam, little will be learned about the coal or anything else. The assumption that a low series of tests is valuable because it is somewhere near operating conditions is wide of the mark, for operating conditions should not be represented by poor results. When an oil is tested on a bearing, the whole thing is made as clean as possible. We do not throw a handful of dirt in with the oil because we believe that the bearing is dirty in everyday work.

The man who runs boiler trials should first learn the fireman's business. Simply measuring coal and water, air pressure and CO_2, and letting a laborer manage the fire, is a poor way of trying out a coal or a furnace.

A class of technical men who will spend a year or two in learning the business of firing is needed in many firerooms; for firing, while dirty work, calls for an educated mind, and such a man could take a small group of boilers with the usual fireroom help and carry perfect fires. There could be a number of such men in any large fireroom, each in his overalls, with goggles in his pocket and the common equipment of boiler-room instruments at hand. His would be the controlling judgment of the fires. He would know when holes were coming and when clinkers were forming. If draft was deficient, he would know why and what move must be made.

Such men are not easily obtainable. I know of but two technical men who have been willing to work at stoking, though no doubt there are many more. And new methods in the fireroom would be necessary, for such men must be given authority and adequate salary. But they would make it possible to avoid a drop of proper efficiency at 80 per cent to an improper one of 60 per cent. Labor costs might increase, perhaps, at first, but the labor cost is only 6 per cent of the fuel cost so that 15 per cent more labor is only 1 per cent of the fuel. With present methods a change of 1 per cent in fuel, particularly tending toward lower efficiency, is never noticed. The ultimate effect would be toward lower labor cost and much lower fuel cost.

EDITORIAL COMMENT

A Vicious Example.

STRIKES, like war, are notoriously unprofitable—a manifestation of the eternal falsity and failure of the policy of government by force. They prove nothing but the temporary location of the balance of power. They settle nothing (unless accidentally or incidentally) except the dictates of transient expediency.

Seldom, however, has a strike been so utterly unamiable, from every point of view, as that of the traction company's employees in Philadelphia, which, at the time of writing, is still unsettled. No one of the parties involved—corporation management, labor union, or municipal government—awakens even for the shortest moment one of those invigorating pulses of sympathy that is sometimes aroused in a bystander by evident sincerity of purpose, even when that purpose is misguided and misdirected. Unionism and anti-unionism are both seen at their worst, and the vicious quarrel goes on, in contemptuous disregard of nominal efforts toward law and order by a police force corrupt to the point of utter inefficiency.

The only uplift amid the whole demoralizing spectacle is the effect produced by the State constabulary—an evidence of the power inherent in a little clean honesty and courage when it determines to assert itself.

Fallacies in Economics.

HE opponents of protection hate it so cordially for itself alone that any suggestion of secondary ill effects is supererogatory. Nevertheless it is quite possible that much of the economic disturbance in the United States today is collaterally, if not lineally, descended from the "parent of the trusts." The disturbance here referred to is not the physical disturbance, so to speak, of artificially maintained prices and general though unequal inflation of values. It is the mental disturbance unconsciously bred by the conception of legislation as something superior to economics—of statute law as something that can overrule and reverse natural law. The inference is easy. Tariff advocates have always asserted that prosperity in the United States is the direct, necessary, and sole result of protection. If, then, one legislative measure can make one class or part of the nation great and rich, some other bill or law should be equally effective in making another class or section of the people great and rich. Next, by a simple extension of functions, legislation may and must prescribe just how great and rich each class shall be. All legislation tends to become special, conferring, withholding, extending, limiting, or regulating privileges and profits.

The corrupting tendencies of such a state are apparent. But beyond plain vulgar dishonesty, it creates the delusion that by the making of many statutes we shall bring in the millennium—at least, we shall have no difficulty in annulling the laws of economics or changing the constants of nature. When one measure fails to produce the expected result it is amplified by another, until enterprise, industry and traffic are so baffled on every side by artificial barriers that the current wastes its energy in whirls and eddies, grows sluggish, and stops. The country gropes, bewildered, in a maze of railroad and corporation legislation, where the simple necessity has been, and still is, a plain interpretation, energetic prosecution, and vigorous enforcement of common law and equity—or above all, of the penal statutes.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

ALLOYS OF COPPER, ALUMINIUM AND MANGANESE.

A SUMMARY OF THE NINTH REPORT TO THE ALLOYS RESEARCH COMMITTEE OF THE INSTITUTION OF MECHANICAL ENGINEERS.

W. Rosenhain and F. C. A. H. Lantsberry—Institution of Mechanical Engineers.

THE eighth Report to the Alloys Research Committee of the Institution of Mechanical Engineers, an abstract of which was given in THE ENGINEERING MAGAZINE for March, 1907, described an extensive research into the properties of the alloys of copper and aluminium, up to a point "where the way was clear for investigating the influence of a third metal." During the last three years, ternary alloys of copper, aluminium and manganese have been under investigation by W. Rosenhain and F. C. A. H. Lantsberry, and the literature of metallurgy is now enriched by the appearance of the ninth Report to the Alloys Research Committee, which deals exhaustively with the properties of these alloys. We choose from the voluminous data given in the 174 pages of the Report a few results which give at least a general indication of the effect of the addition of manganese on alloys of copper and aluminium, and of the possibilities of practical utility which inhere in the alloys investigated.

Considering first the alloys rich in copper, a series of exploratory tests on twenty-two alloys of copper and aluminium lying within the limits of an aluminium content of 11 per cent. and a manganese content of 10 per cent. resulted in the selection for preparation on a large scale and for more complete investigation of nine alloys, ranging in manganese content from 0.5 per cent. to 5 per cent., and in aluminium content from 7 to 10 per cent. The general inference drawn from the result of the exploratory tests is that the effect of manganese is in most respects similar to that of aluminium itself, but that while larger additions of manganese render the alloy brittle and weak. the first effects of adding small quantities of manganese are to stiffen the alloys, that is, to raise both their yield points and ultimate strengths without diminishing their ductility. Although only three of the nine alloys selected were found sufficiently promising to warrant complete study (including kinetic tests), tensile tests on sand-cast, chill-cast, rolled, and cold-drawn bars gave a series of interesting results, several of the alloys proving themselves decidedly superior to any of the binary alloys of copper and aluminium. For instance, in the case of sand castings, alloy No. 2, containing approximately 10 per cent. of aluminium and 1 per cent. of manganese, showed a yield point of 14 tons per square inch, an ultimate stress of 35.76 tons per square inch, and an elongation of 22.5 per cent. on 2 inches; the best of the binary alloys gave a yield point of 11.3 tons, an ultimate stress of 31.7 tons and 21.7 per cent. elongation on two inches in the form of sand castings. Alloy No. 6 of the present series, containing approximately 9 per cent. of aluminium and 2 per cent. of manganese, gave almost exactly the same yield point and ultimate stress as the 10 per cent. copper-aluminium alloy, but shows 46 per cent. elongation on 2 inches as compared with 36 per cent. In the form of rolled bars, 13/16 inch in diameter, the best of the ternary alloys attain an ultimate stress of nearly 43 tons per square inch, with a yield point of 23 tons and an extension of 22.5 per cent., while another alloy, with a yield point of 19 tons and an ultimate strength of 40.5 tons, shows an elongation of 40 per cent. on 2 inches. The results of these tensile tests lead to the definite conclusion indicated above, that the effect of the addition of manganese in relatively small amount to an alloy of aluminium and copper is to stiffen the alloy.

Notwithstanding the comparatively wide variations of tensile strength which exist between these nine alloys, their hardness numbers were found to differ very slightly; the Brinell number varied from 170 to 199. The torsion tests yielded results generally consistent with those of the tensile tests; alloy No. 9, however, containing approximately 8 per cent. of aluminium and 5 per cent. of manganese, was remarkable in giving both the highest maximum strength in torsion and the largest angle of twist. The ratio of the maximum stresses in torsion and in tension varied from 0.75 to 0.90, but never reached or exceeded unity, as was the case with a number of the binary copper-aluminium alloys. Under the alternating-stress test none of the nine alloys gave as good a result as one of the binary alloys of copper and aluminium, but taking into consideration their much higher tensile strengths, their behavior under this test was remarkably good.

The three alloys chosen for complete study were No. 2, manganese 1 per cent. and aluminium 10 per cent.; No. 3, manganese 2 per cent. and aluminium 10 per cent; and No. 6, manganese 3 per cent. and aluminium 9 per cent. The tests included a determination of the elastic limit and elastic modulus, the autographic stress-strain diagram, the investigation of the effect of cold drawing on the elastic modulus of the alloys, tensile tests at high temperatures (up to 450 degrees C.) a series of dynamic tests, an examination of the effects of heat treatment, and fresh- and sea-water corrosion tests.

The elastic limits for the three alloys in numerical order were found to be approximately 8, 9, and 12 tons per square inch, while the elastic modulus ranged from 13.6×10^6 pounds per square inch in No. 2 to 14.9×10^6 in No. 6. Cold drawing does not appreciably alter the modulus, although the elastic limit is, of course, very considerably raised. The low values of the elastic moduli as compared with those of steel are important as affecting the possible utility of these alloys in high-speed machinery, etc.

The results obtained in the tensile tests at high temperatures were very similar to those found for the 10 per cent. copper-aluminium alloy: the tensile strength appears to be well maintained up to about 300 degrees C. but then falls off rapidly. There is some reason for believing, however, that on prolonged exposure to moderately high temperatures the ternary alloys would behave better than the pure copper-aluminium alloys.

The dynamic tests included alternating-stress tests by direct reversals of stress, single-blow impact tests on the Izod machine, and repeated bending-impact tests with two different values of blow. Under direct-reversal tests the three alloys behaved practically identically; the results indicate that the safe range of maximum stress is approximately 25 tons per square inch when the rate of reversals approaches 1,000 per minute, about 1 ton less than the figure for the 10 per cent. copper-aluminium alloy. Under the single-blow impact test, on the other hand, the present alloys showed an absorption of from 9.5 to 10.5 foot-pounds for fracture, the figure for the 10 per cent. copper-aluminium alloy being only 4.5; evidently manganese increases the power of copper-aluminium alloys to resist sudden shock. Under the repeated bending-impact test, with a tup weighing 6.15

pounds falling through a height of 2.01 inches, alloy No. 2 fractured only after more than 900 blows, while No. 6 failed under 600. With the lighter tup (4.71 pounds) and lesser fall (1.01 inch) ordinarily used in impact tests on steel, the order of the alloys was changed; all three, however, required over 10,000 blows, while the best result yet obtained with Swedish Bessemer steel under the same conditions is a resistance to 6,000 blows.

The three alloys were found to offer a most remarkable resistance to abrasion. While rings of rail steel lost 64.5 milligrams and a ring of tool steel 27 milligrams, a ring of Alloy No. 6 lost only 10 milligrams and the other two alloys behaved nearly equally well. If the behavior of the alloys in practice should bear out these remarkable results, a field of special usefulness should be open to them, particularly as the alloys machine quite readily. All the alloys exhibited also a marked resistance to corrosion in fresh and sea water. In fresh water the ternary alloys appear to be decidedly less liable to corrosion than the binary alloys of copper and aluminium; in sea water, on the other hand, alloy No. 2 appears to lose nearly as much by corrosion as Naval brass; in alloy No. 6 no corrosion whatever was observed.

Turning now to the alloys rich in aluminium, a preliminary study of the aluminium-manganese series of binary alloys showed that a binary eutectic exists close to the aluminium end of the series, while the alloys on the manganese side of this eutectic contain increasing quantities of the compound Al_3Mn, a hard brittle compound which at once limits the possible extent to which manganese can be usefully added to alloys consisting principally of aluminium. The study of tenary alloys was, therefore, confined to the range containing less than 4 per cent. of either copper or manganese. The results of tensile tests on eight alloys in this range, while not very promising in themselves, indicated that two alloys, containing, respectively 2 per cent. copper and 2 per cent. manganese, and 3 per cent. copper and 1 per cent. manganese, were worthy of further study. The investigation of these two alloys was carried out along the same general lines as those followed in studying the alloys rich in copper.

An interesting feature of the results obtained with these alloys is the determination of the very great extent to which the properties of the metal depend, in the case of castings, on the temperature at which the metal is poured into the moulds. Tensile tests of sand castings of the two selected light alloys show that they compare favorably with pure copper-aluminium alloys, and this is still more notable in the case of chill castings. The tensile tests of alloy No. 11 (3 per cent. copper, 1 per cent. manganese) which show an ultimate strength of 12 tons per square inch, with an elongation of 13.5 per cent. on 2 inches, are among the most remarkable results of this investigation of ternary alloys, since they very considerably exceed the results of any of the binary alloys of aluminium with copper. This superiority, however, is not maintained in the case of rolled bars; although the results are slightly better than those found in the binary series, the difference is not nearly so important as in the case of chilled castings. There does not seem to be any advantage in using the ternary alloys as compared with the alloys of aluminium with copper alone. It was found also that the two light alloys could not be drawn cold to any considerable extent without drawing hollow, even the amount of cold working attempted in the case of alloy No. 11 in the process of "drawing and annealing" producing hollowness. Alloy No. 10, however, containing 2 per cent. of each added metal, stood the process of drawing with annealing in a satisfactory manner. The specific gravities of the two alloys range from 2.71 to 2.80 for No. 10, and from 2.67 to 2.79 for No. 11. In all cases the rolled material was markedly denser than the chill cast.

The elastic limit is 7.15 tons for both alloys, and the elastic moduli are 10.75×10^6 and 10.4×10^6 respectively. The alternating stress tests indicate that the safe range for alternating stresses is for alloy No. 10, 9.4 tons per square inch, and for alloy No. 11, 8.8 tons per square inch. Under the single-blow impact tests the two alloys absorbed 4.1 and 5.5 foot-pounds at fracture, surprisingly high results in view of the relatively low tensile strength of the materials. Under the repeated bending-impact test as applied to the heavy alloys or to steel specimens, these light alloys would have fractured after very few blows; a lower height of drop was accordingly employed (0.71 inch instead of 1.01 inch) and with a tup weighing 4.71 pounds the alloys fractured after 590 and 672 blows respectively.

Special experiments were made on both heavy and light alloys to determine whether the alloys could be prepared from manganese derived from a commercial 80 per cent. ferro-manganese. In the case of the heavy alloys, the results showed that if a cupro-ferro-manganese is first prepared and the alloy made from this the results are satisfactory, but that it is not possible to use ferro-manganese directly for the preparation of the copper-rich alloys. In the tests on alloys rich in aluminium, an alloy of the type of No. 10, prepared by the use of ferro-manganese direct and containing 0.52 per cent. of iron, gave results appreciably better than those obtained from the original No. 10. It is probable that the introduction of small proportions of iron may materially improve these light alloys.

GRAPHITE AS A LUBRICANT.

ADVANTAGES OF USING DEFLOCCULATED GRAPHITE WITH OTHER LUBRICANTS.

Charles M. Mabery—American Society of Mechanical Engineers.

IT has been claimed that in the case of considerably more than half of the 10,000,000 horse power in use in Great Britain, 40 to 80 per cent. of the fuel is spent in overcoming friction and that a considerable proportion of this power is wasted by imperfect or faulty lubrication. In the United States the condition is often worse, and losses of 50 per cent. or greater are found in factories by lubrication experts where the annual expense for lubrication amounts to thousands of dollars. Imperfect and inefficient lubrication was the rule in the days before the use of products from petroleum, and it was not until the discovery that the heavy hydrocarbons in petroleum possessed the qualities requisite for lubrication—viscosity, durability and stability that a new era in lubrication was begun. In fact, modern high speeds and excessively heavy loads early demanded better lubrication, and this was first met by the use of the heavier hydrocarbons. Otherwise the earlier methods have undergone but little fundamental change and indeed for lighter work good oils composed for the most part of the hydrocarbons $C_n H_{2n}$ and $C_n H_{2n-2}$ have been obtained from the crude oils of the Pennsylvania type containing a considerable proportion of the hydrocarbons $C_n H_{2n+2}$. These compound oils were used, petroleum products being mixed with vegetable oils and various animal oils and greases, and also heavier lubricants obtained from Texas and California petroleum. The superiority of an ideal solid lubricant, that is, one that should embody an equivalent of the desirable qualities of the liquid products with a greatly superior wearing quality and a low coefficient of friction and at the same time a substance readily convertible into a form that can be conveniently applied to the various forms of journals and bearings, has always been recognized.

According to Professor Mabery, who reported the results of extended experiments at a recent meeting of the American Society of Mechanical Engineers, soapstone asbestos, natural graphite, etc., do not altogether possess these fundamental qualities of the liquid products. Greases compounded with graphite are useful on low-speed bearings and under heavy work. Natural graphite serves an excellent purpose on cast-iron bearings, acting as a surface evener of the porous metal. On finer surfaces care is necessary that it does not collect in such quantities as seriously to scratch or abrade the journal and bearing.

Of all the solid bodies available for lubrication, graphite possesses the desirable unctuous quality and great durability, and when in its purest condition and in a state of extreme subdivision it is a most useful lubricant. As made by the Acheson process two forms of commercial graphite for this purpose are produced, the unctuous and the deflocculated modifications. The first is leafy in structure, coherent, and extremely unctuous or greasy to the touch; it is segregated and not highly disintegrated. The second is also unctuous in a high degree, but very pulverulent and capable of extreme subdivision; it is readily converted into a deflocculated condition. This form in water forms the commercial "Aquedag" or aqueous Acheson deflocculated graphite. In combination with oils it is known as "Oildag." The small quantity of graphite distributed by water between a journal and bearing while sustaining a load of 70 pounds per square inch is really remarkable especially when it is considered that under high speed conditions it maintains an extremely low coefficent of friction.

All proper lubrication necessarily presupposes proper bearings and this involves their care and maintenance. A lubricant is merely an unctuous body that readily forms a continuous, coherent, durable film capable of holding apart rolling or sliding surfaces, and itself interposing the least possible resistance. The economic problem in lubrication depends upon the use of such a lubricant under suitable conditions. Water in itself possesses no oiliness whatever, but in certain circumstances in cylinders it is found to assist in imparting to the metallic surfaces an extremely smooth condition, which serves materially to reduce the friction.

The distillation and refining of oils has much to do with the final product and the elimination of acid products by the use of caustic soda without producing such an excess as will produce an emulsion is one of the problems of the refinery. The ordinary tests of lubricating oil include the determination of the viscosity, specific gravity, flash and fire temperatures, while an essential not so readily determinable is that of oiliness or greasiness. In addition there are mechanical tests where the effects of speed, load, temperature, and the frictional effects due to viscosity and oiliness are studied.

Professor Mabery's studies were undertaken with the Carpenter machine and involved not only the ordinary use of lubricants but those with which graphite was mixed and also water, kerosene, and fuel oil containing graphite, the amount added in each case being 0.35 per cent. From his experiments, Professor Mabery reached the conclusion that in the deflocculated form graphite could be used as a solid lubricant with great economic efficiency in all forms of mechanical work. "One of its most characteristic effects is that of a surface-evener, by forming a veneer, equalizing the metallic depressions and projections on the surfaces of journal and bearing; and being endowed with a certain freedom of motion under pressure, it affords the most perfect lubrication. In automobile lubrication the great efficiency of graphite, in increasing engine power, in controlling temperatures, and in decreasing wear and tear on bearings, has been brought out in a series of tests conducted by the Automobile Club of America. In connection with the reduction in friction of lubricating oils by graphite the extremely small proportion necessary is worthy of note; the proportion used in this work is equivalent to one cubic inch of graphite in three gallons of oil. The curve of temperature for Aquadag, which shows an increase but slightly above that of the surrounding atmosphere, demonstrates an important economic quality of controlling temperatures in factory lubrication, thereby avoiding the danger of highly heated bearings which are frequently the cause of fires." The advantage of graphite was also most striking in the tests where graphite was used with water, the latter serving merely as a vehicle and being devoid of lubricating property.

THE TRAINING OF MEN.

PRACTICAL TRAINING COMBINED WITH EDUCATIONAL WORK AS DEVELOPED AT THE WEST LYNN WORKS OF THE GENERAL ELECTRIC COMPANY.

M. W. Alexander—American Society of Mechanical Engineers.

THE comprehensive apprenticeship system developed at the Lynn works of the General Electric Company is described in a paper by Mr. Magnus W. Alexander, read recently before the American Society of Mechanical Engineers, and published in the *Journal* for January. It will be recalled that in 1906, after the appentice system had been for several years in successful operation at the Lynn Works, Mr. Alexander discussed it most fully in a paper which was abstracted in THE ENGINEERING MAGAZINE for January, 1907. Since that time the educational system, which aimed at training as trade apprentices boys of grammar school education has been extended, so that in addition provision has been made for training machine specialists from the ranks of the workmen, foremen, designers, superintendents from the highly skilled and more intelligent mechanics, draftsmen, testers, erectors, and business workers from high-school graduates, and finally for providing suitable advanced work for the university graduate so as to train him for a position of maximum usefulness.

The regular apprentice training has been maintained essentially along the lines outlined by Mr. Alexander in his previous paper, but the work has been developed and extended wherever possible. Boys of at least 15 years of age are taken for a four years course to fit them to become tool and die makers, instrument makers, and pattern makers, and boys slightly older for a three years course to become iron, steel and brass molders, blacksmith and steamfitter apprentices. During this time they receive regular and liberal compensation and are given special daily instruction in the class room as well as in the training rooms and shops, the instruction being under a special superintendent.

"The training room is a special department for apprentices, a trade school in the factory, with this distinction, however, that all work is commercial work selected solely for its instructive character. It had its inception in the belief that the apprentice should receive his initial training under the most favorable conditions and expert supervision. The very fact of this work being part of the commercial output of the factory automatically insures a high standard of quality and quantity, and eliminates the false notions of these values usually found in purely educational trade schools. As a matter of record the work of the apprentice is of a very high standard. Moreover on work of a repetitive character, the apprentices attain a speed of from two-thirds to three-quarters of that of the average workman, and a quality of work fully equal to the average. On work generally classed as 'tool work,' the apprentices very closely approach and sometimes even equal the work of the skilled journeyman."

"Training rooms have been established for tool-maker and pattern maker apprentices, occupying departments of about 15,000 square feet, and 4,000 square feet, respectively. No training room has yet been organized for molder apprentices, as there are only a few of them and as this part of the system is not yet very far developed. The training rooms are in charge of expert mechanics who act as assistant foremen to the superintendent of apprentices." Few of these expert mechanics are required, as the apprentices themselves act as instructors to those less advanced, and this is not only valuable for its economy but for its educational value in developing the apprentices themselves. Good apprentice wages are paid by the company and a high standard of work is maintained so that a large number never pass beyond the initial probationary period, while throughout their course they are carefully watched. At times apprentices are loaned to the factory for a few days or weeks and at the conclusion of the course they are ready for steady employment at good wages.

There are over 200 trade apprentices at the Lynn Works and 101 have already graduated, of whom 63 are in the employ of the company, 8 serving as assistant foremen, 5 as inspectors, and 12 as tool draftsmen, while the remainder are skilled journeymen. The point is made clear to all apprentices, however, that a position as foreman or superintendent should not be the sole aim except for those with predominant ability.

Training for positions as draftsmen and designers is limited to young men with a complete high-school education who pass examinations in algebra, plane geometry and elementary physics. Before being indentured as draftsmen apprentices the candidates must serve a trial period of two months. The period is three years and the compensation is 10 and 12 cents per hour respectively for the first and second six month periods, 15 cents for the second year, and 20 cents for the third year. They receive then a cash bonus of $75 and a Certificate of Apprenticeship which states their efficiency in practical and theoretical work. They receive instruction of college rank daily except on Saturday and during part of the summer, the subjects covered being advanced algebra, descriptive and analytic geometry, plane trigonometry, advanced physics, inorganic chemistry, strength of materials and machine design. The closest correlation is maintained between the theoretical and practical and examinations are held three times a year at which a mark of 70 per cent is required.

Draftsman apprentices receive machine-shop training during the first year and a half and drafting instruction during the remainder of the three years' course. The machine-shop work is given principally in the apprentice training room and part of the time is devoted to repair work on machinery and to tool work in order to instill into the mind of the future draftsman the possibilities and limitations of the shop as well as methods for most economical manufacture. The drawing office instruction is of a high standard and one object of the present course was to improve the standards of draftsmanship which had deteriorated in recent years. Accordingly it was decided to demand an entrance examination of a candidate before his commencing the course, and then to develop not only competent tool and mechanical draftsmen but high-grade intelligent designers.

The most recent provision for systematic training at the Lynn works has been the establishment of courses open to high-school graduates in which young men are prepared to become testers and erectors of machinery and are fitted for business careers in a manufacturing establishment.

"Tester apprentices must pass an examination the same as draftsman apprentices, and the length of the two courses and the rates of compensation are identical. The practical work consists of about six months of testing motors or transformers, followed by about nine months of assembling and winding the remaining year and nine months being devoted to a training in the various testing departments for meters and instrument, arc lamps, rectifiers, railway motors, and special electrical machinery, also turbines and turbo-generators."

"Business apprentices are recruited from high-school graduates who have a leaning towards business activity, but not sufficiently high scholarship to pass the entrance examination and continue the educational work prescribed for the drafting and testing courses. These apprentices enter upon a two years' course at a compensation of 12 cents per hour for the first year and 15 cents for the second year, with a cash bonus of $50 at the successful termination of the course. They begin with six months of general stockkeeping, which acquaints them with the principal materials used in the factory, and leads to an appreciation of the value of these materials. Then follows a nine months' training on the writing of material lists and the compiling of stock reports. In this way the apprentices learn to read drawings and to make up lists of the kinds and amounts of materials required for the production of one or several machines or machine parts delineated on drawings. They learn furthermore, to calculate the losses that result from the cutting off of bars and the punching of various shaped parts. All this leads to accuracy and develops an interest in the value of stock which will show in the stockroom work of a more independent character which occupies most of the remaining nine months. These apprentices will also be given a training in shop clerical work, and this will be supplemented by instruction in arithmetic and geometry, the reading of drawings, and simple bookkeeping."

The General Electric Company established many years ago, a "student course" for young men of collegiate engineering training providing for a two years' experience in the various testing departments. In its present form the student course is divided into "engineering" and "commercial" courses. Admittance to either is dependent upon a complete engineering-college education, and almost invariably applicants are required to appear before a committee. The courses last two years and the compensation has been set at 20 cents per hour ($11 per week) for the first year, 22½ cents per hour ($12.37 per week) and 25 cents per hour ($13.75 per week) respectively for the two halves of the second year. Without written agreement it is mutually understood that the student will give to the company two years of faithful service, and that the company on the other hand reserves the right to terminate the work of any student who at any time proves that he is not above the average either in capacity and special fitness or in good intentions. There are weekly evening lectures which all students are expected to attend, when the engineers and foremen of the company as well as the heads of the business departments informally address the young men and stimulate a frank and free discussion of the subject under consideration. These lectures cover the principal materials of construction, important manufacturing processes, and the various lines of apparatus manufactured by the company, and put the student in the possession of up-to-date practical information which they would not be able to get from books or other outside sources. Lectures are also given on business methods. Commercial students throughout their course work in the shops and testing rooms on construction, assembling, repairs and tests, and spend about two months on meter and instrument testing, two and a half months on arc lamp testing and repairing, one and a half months on transformer winding and assembling, four months on transformer and rectifier testing, two and a half months on stationary and railway motor winding and assembling, six months on stationary and railway motor testing, and five and a half months on turbine testing or in other special assignments. They are stimulated to keep in touch with the latest engineering developments by reading the technical magazines and are shown the value of following up the advertisements in them as one means of getting acquainted with the general features of apparatus manufactured by competitors, while they are encouraged to observe such machinery and instruments under actual use.

The engineering students receive most of their training in the machine shops, winding department and drawing office, while the latter part of the course is devoted to testing, or to production cost or other business activities as the individual student may make advisable. The first work usually is in the apprentice training room and then a period in various departments of the factory follows when they are required to study problems of production. The next division of the student's time is spent in the drafting office working on detail drawings, assembly and lay-out work and problems of design, especially with a view to economic wholesale manufacture. The final period of the course is spent in specific work along lines leading to some definite occupation after graduating from the course in which the student's aptitude or proficiency has indicated his field of greatest usefulness.

THE COST OF MILL BUILDINGS.

DIAGRAMS AND TABLES GIVING APPROXIMATE COSTS PER SQUARE FOOT OF TOTAL FLOOR AREA OF BRICK AND FRAME MILL BUILDINGS.

Charles T. Main—Engineering News.

THE paper from which the diagrams and tables on the following pages are taken was originally presented by Charles T. Main before the New England Cotton Manufacturers' Association about six years ago. Revised to conform with prices prevailing about January, 1910, it is reprinted in *Engineering News* for January 27. The diagrams show the approximate cost per square foot of total floor area of brick mill buildings of various dimensions and from one to six stories in height. The costs used in making up the diagrams are based largely upon the actual cost of work done under average conditions of cost of materials and labor, and with average soil for foundations. In the tables are given factors by which the cost of frame structures may be calculated from the cost of buildings of the "slow-burning type" as given in the diagrams.

The diagrams can be used to determine the probable approximate cost of proposed brick buildings, of the type known as "slow-burning," to be used for manufacturing purposes. The curves, which were derived primarily to show the estimated cost per square foot of gross floor area of brick buildings for textile mills with a total floor load of about 75 pounds per square foot, include the cost of ordinary foundations and plumbing, but no allowance is made for heating, sprinkler or lighting systems; these items would add roughly 10 cents per square foot of floor area. The costs given, of course, refer only to average conditions; they may require modification to meet extraordinary conditions, among which may be mentioned the following:

(*a*) If the soil is poor or the conditions of the site are such as to require more than the ordinary amount of foundations, the cost will be increased.

(*b*) If the end or a side of the building is formed by another building, the cost of one or the other will be reduced slightly.

(*c*) If the building is to be used for ordinary storage purposes with low stories and no top floors, the cost will be decreased by from 10 per cent for large low buildings to 25 per cent for small high structures, about 20 per cent usually being a fair allowance.

(*d*) If the buildings are to be used for manufacturing purposes and are to be substantially of wood, the cost will be decreased by from 6 per cent for large, one-story buildings, to 33 per cent for small, high buildings; 15 per cent would usually be a fair allowance.

(*e*) If the buildings are to be used for storage, with low stories and built substantially of wood, the cost will be decreased by from 13 per cent for large, one-story buildings to 50 per cent for small, high buildings; 30 per cent would usually be a fair allowance.

TABLE I. RATIO OF COST OF VARIOUS BUILDINGS TO THAT OF BRICK MILLS, STANDARD CONSTRUCTION.

Superficial feet of Floor in	Frame Mills.						Brick Store House.						Frame Store House.					
one story.	1 Sto.	2 Sto.	3 Sto.	4 Sto.	5 Sto.	6 Sto.	1 Sto.	2 Sto.	3 Sto.	4 Sto.	5 Sto.	6 Sto.	1 Sto.	2 Sto.	3 Sto.	4 Sto.	5 Sto.	6 Sto.
1,250	.86	.67					.80	.73					.70	.51				
2,500	.86	.73					.85	.73					.75	.58				
5,000	.89	.78	.75	.73	.70	.67	.83	.80	.78	.76	.76	.75	.74	.60	.56	.53	.51	.48
7,500	.90	.79	.77	.74	.71	.69	.85	.81	.78	.77	.76	.76	.77	.63	.58	.55	.53	.51
10,000	.90	.80	.78	.75	.73	.70	.87	.81	.79	.78	.77	.76	.78	.65	.60	.57	.55	.53
15,000	.91	.82	.79	.77	.75	.72	.89	.83	.81	.79	.78	.78	.81	.67	.64	.61	.59	.56
20,000	.92	.83	.81	.79	.77	.74	.90	.84	.82	.80	.80	.79	.82	.70	.67	.64	.61	.59
25,000	.92	.85	.82	.80	.78	.76	.91	.85	.83	.82	.81	.80	.83	.72	.69	.66	.63	.61
30,000	.93	.86	.84	.81	.80	.77	.91	.86	.84	.82	.81	.81	.84	.73	.70	.67	.65	.62
35,000	.93	.87	.84	.82	.80	.78	.92	.86	.84	.83	.82	.81	.85	.74	.71	.68	.66	.63
40,000	.93	.87	.85	.83	.81	.79	.92	.87	.85	.84	.83	.82	.86	.75	.72	.69	.67	.64
45,000	.94	.87	.85	.83	.82	.79	.92	.87	.85	.84	.83	.82	.86	.76	.72	.70	.67	.65
50,000	.94	.88	.86	.84	.82	.80	.92	.88	.86	.84	.83	.83	.87	.77	.73	.71	.69	.66

(*f*) If the total floor loads are more than 75 pounds per square inch the cost is increased.

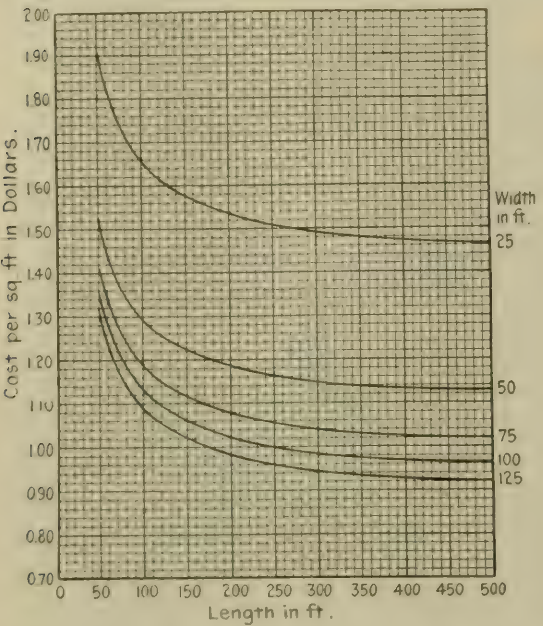


FIG. 1. COST OF ONE-STORY BRICK BUILDINGS.

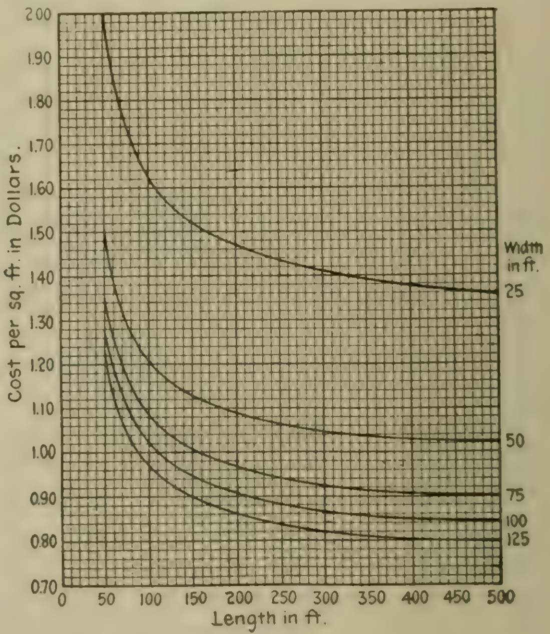


FIG. 2. COST OF TWO-STORY BRICK BUILDINGS.

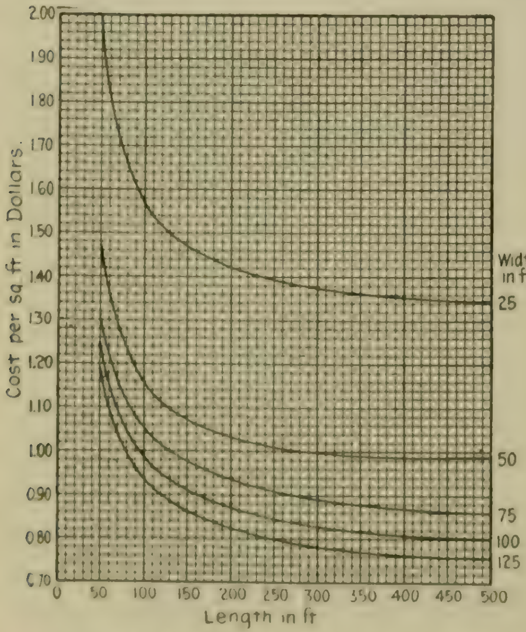


FIG. 3. COST OF THREE-STORY BRICK BUILDINGS.

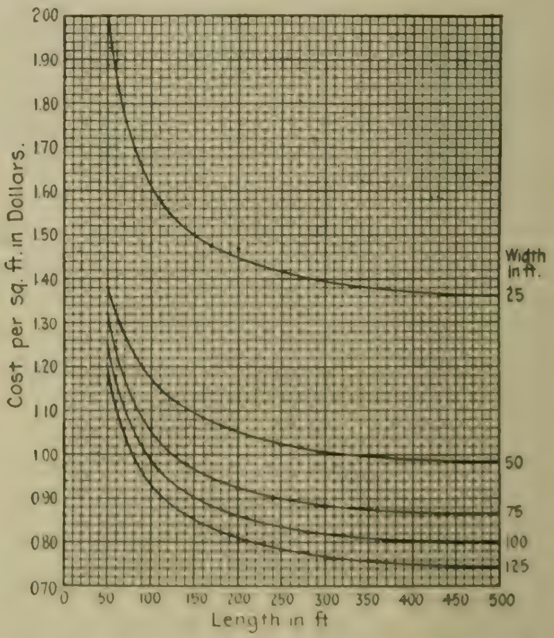


FIG. 4. COST OF FOUR-STORY BRICK BUILDINGS.

(*g*) For office buildings, the cost must be increased to cover architectural features in the exterior and interior finish.

The cost of very light wooden structures is much less than the above figures would give. Table I shows the approximate ratios of the costs of frame mills, brick store houses and frame store houses to the cost of standard mill construction as shown in the curves.

The costs which form the basis of the estimates are shown in Table II. The cost of brick walls is based on 22 bricks per cubic foot, costing $18 per thousand laid. Openings are estimated at 40 cents per square foot, including windows, doors, and sills. Ordinary mill floors, including timbers, planking and top floor with Southern pine timber at $40 per thousand feet, board measure, and spruce planking at $30 per thousand feet, cost about 32 cents per square foot; this has been used as a unit price. The cost of ordinary mill roofs covered with tar and gravel, with timber at the prices given above, has been taken as 25 cents per square foot.

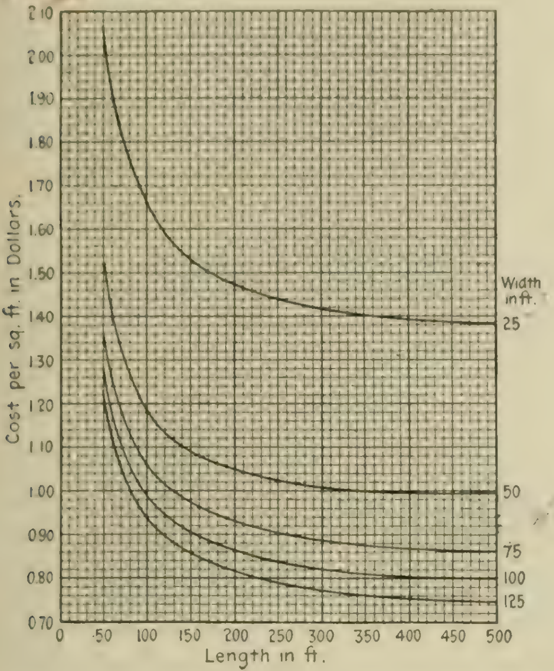


FIG. 5. COST OF FIVE-STORY BRICK BUILDINGS.

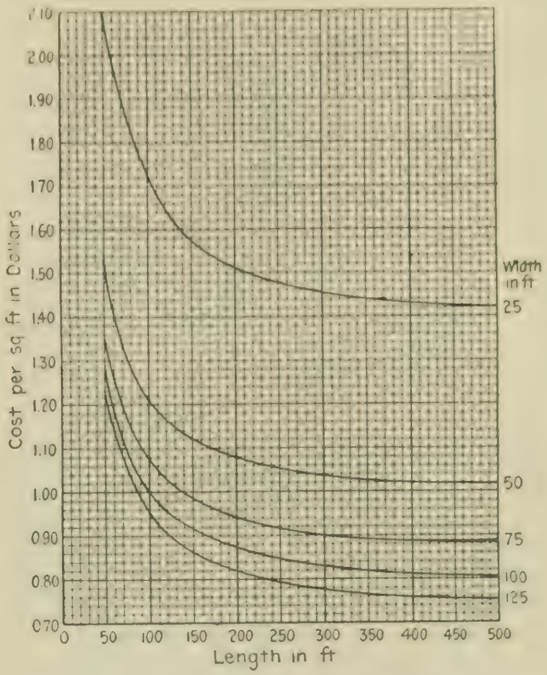


FIG. 6. COST OF SIX-STORY BRICK BUILDINGS.

An examination of the diagrams reveals several interesting facts. Perhaps the most apparent is the decrease in cost as the width of buildings is increased. This decrease is due to the fact that the cost of the walls and outside foundations which is an important item relative to the total cost, is decreased as the width increases. Further, it is apparent that the minimum cost per square foot is reached with a four-story building; a one-story building is the most expensive. The cost of the roof is the same no matter what the number of stories, and the costs of foundations and columns do not increase in proportion to the number of stories; the cost of the walls, however, increases in a greater proportion than the number of stories; in the four-story building the saving per square foot in the cost of foundations and columns with increased height, and the increased cost of walls with increased height are balanced. The diagrams and tables show that the saving in the use of frame construction instead of brick is not so great as is popularly supposed. The only saving is in the cost of the somewhat lighter foundations and of the outside walls. The floors, columns and roof must be of the same strength and type of construction in any case.

The height of stories assumed in making the calculations for the curves are as follows: from ground to first floor, 3 feet; height of stories for buildings 25 feet wide, 13 feet; for buildings 50 feet wide, 14 feet; for buildings 75 feet wide, 15 feet; and for buildings 100 and 125 feet wide, 16 feet. The cost of stairways, including partitions, is assumed at $100 each flight. Two stairways and one elevator well are allowed for buildings up to 150 feet long, two stairways

TABLE II. DATA FOR ESTIMATING COST OF BUILDINGS.

	FOUNDATIONS, Including Excavations. Cost per linear foot.		BRICK WALLS, Cost per square foot of surface.		COLUMNS, Including Piers and Castings.
	For Outside Walls.	For Inside Walls.	Outside Walls.	Inside Walls.	Cost of One.
One Story Building..............	$2.00	$1.75	$0.40	$0.40	$15.00
Two Story Building..............	2.90	2.25	.44	.40	15.00
Three Story Building..............	3.80	2.80	.47	.40	15.00
Four Story Building..............	4.70	3.40	.50	.43	15.00
Five Story Building..............	5.60	3.90	.53	.45	15.00
Six Story Building..............	6.50	4.50	.57	.47	15.00

and two elevator wells for buildings up to 300 feet long, and in buildings over two stories high, three stairways and three elevator wells for buildings over 300 feet long. In buildings over two stories high, $75 is allowed for each plumbing fixture, including piping and partitions. Two fixtures are allowed for each floor having up to 5,000 square feet of floor space, and one fixture additional for each additional 5,000 square feet or fraction thereof.

The cost of reinforced-concrete buildings designed to carry floor loads of 100 pounds per square foot or less, Mr. Main concludes, would be about 25 per cent more than the slow-burning type of mill construction.

ELECTRIC LIGHTING FOR INDUSTRIAL PLANTS.

A DISCUSSION OF SYSTEMS OF ELECTRIC LIGHTING AS APPLIED TO THE ILLUMINATION OF SHOPS AND FACTORIES.

George H. Stickney—American Institute of Electrical Engineers.

IN concluding a review of modern light sources and methods of industrial illumination in The Engineering Magazine for July, 1909, H. Thurston Owens took occasion to remark that the economic importance in industrial illumination of the high-efficiency light sources which have been developed during recent years lies not so much in the possibilities of reducing lighting bills offered by their substitution for the older forms, as in the increase in the efficiency of workmen which follows any improvement in hygienic conditions. The same view is expressed by George H. Stickney, in a paper on electric lighting for industrial plants read at a recent joint meeting of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, which is published in the *Proceedings* of the former for February.

The illumination of industrial plants, he says, should be planned principally with reference to the needs of the workman. Satisfactory lighting can increase his efficiency by making him at ease with his surroundings; insufficient illumination can make him dissatisfied. The test of satisfactory illumination is the ability of the workman to do his work quickly and well without excessive eye strain. It is seldom practicable to provide illumination equalling daylight in intensity, and usually the less attention called to the artificial illumination the better. A serious objection to placing a small portable light under the control of the workman is that he not only wastes time in experimenting with it, but frequently places it in such a position that it produces a glare in his own eyes or in the eyes of his fellow workmen. A direct glare soon produces eye strain and the workman demands more light, which only makes matters worse at the cost of increased current consumption. A substantial reduction in current consumption can often be obtained in plants using portable lights by the substitution of general illumination, and at the same time a light much better suited to the needs of the workman can be provided. Such a change is usually resisted at first by the workman whose strained eyes seem to require a greater intensity of light for clear vision, but if the change is made diplomatically the results are usually eminently satisfactory.

While the lighting system in any building or room should be designed to fit the existing conditions, the building should itself be made to conform as far as possible with the requirements of good lighting. Interior finish has a considerable effect on the efficiency of illumination; whitening of the walls, pillars and ceilings will produce a remarkable increase in the effectiveness of the light. In a high-studded room the current consumption for lighting may be higher than in a room with lower ceilings, but a high room permits the use of larger light units with wider spacing, an advantage when the cost of installation and maintenance is considered. It is common practice to space lamps one and one-half to two times as far apart as their height above the work. Especially in large rooms the use of low, glaring lights should be carefully avoided; the higher the lamps are hung, the less necessary are precautions for avoiding glare. The large window areas of modern factory buildings increase the effectiveness of daylight illuminaton but necessitate a higher intensity of artificial illumination, partly because workmen accustomed to strong day illumination require relatively intense artificial light, partly because of the loss of artificial light through the windows. Where the conditions permit, much light can be retained in the room by reflection by the use of white curtains. In general, processes requiring most light are located near windows and it is well in arranging lamps in a room to favor those parts which have the best daylight.

A room may be lighted by either one of two methods, by local illumination, in which a small lighting unit is placed at each point where particular illumination is required, the other parts of the room depending on low general illumination, or by general illumination, involving the use of relatively large units systematically arranged so that all parts of the room receive approximately the same amount of illumination. General illumination has the advantage that the lighting system, being independent of the detail arrangement of machinery, does not require change with re-arrangement of the work; it does away with temporary construction and the unsightly drop cords, the use of which involves high depreciation and, in many cases, fire risk. General illumination gives a softer and better diffused light, and permits the use of the most efficient illuminants with least wiring and maintenance expense. The choice between general and local illumination, however, is governed to a certain degree by the process to be illuminated. Where, for instance, work is concentrated, general illumination can be used economically; where only a few widely separated points require light, local illumination will be the cheaper.

"In machine shops general illumination can usually be used to good advantage, although some special operations require local lighting. Such local lighting is sometimes provided by loaning extension lamps to the workmen on check, after the practice followed with tools. This practice is often used for automatic machinery, where special light is required for setting up, though a low general illumination is suitable for regular operation. Ordinary machine-shop work requires about 3 foot-candles, though for rough work 1 foot-candle is often satisfactory, while for fine work 6 or more foot-candles may be required. The presence of many overhead belts makes the elimination of shadows with general illumination more difficult, and also is apt to be destructive to drop lights. Modern shops use as few overhead belts as practicable.

"In drafting rooms at least 6 foot-candles should be provided on the drawing board. The selection between general and local illumination depends upon the arrangement of the room and other conditions. Where local lighting is used lamps should be shaded to cut off glare, and if possible located out of the draftsman's reach over the table a little to his left."

The circuits for feeding factory lighting are usually determined by the central-station current available or the requirements of the electric motors in the plant. Either alternating or direct current can be used to equally good advantage; arc lamps, however, do not give a steady light on 25-cycle circuits. The most satisfactory voltage is between 100 to 125, as the most efficient lamps are most readily applied to these voltages. The 220-volt three-wire circuit is commonly used to good advantage. Where motor service is intermittent, affecting the voltage regulation of a local circuit, it is desirable to separate the lighting and power circuits as far as possible. Series circuits should be avoided except when they can be safeguarded. Careful study is usually warranted in dividing up circuits and locating switches to accommodate the requirements of particular processes.

Of the lamps available for industrial illumination, none is suitable for all conditions of lighting. It is often desirable to use several types in different parts of the same plant. Of the principal types of incandescent lamp, the carbon, glower, tantalum and tungsten, the first is economical only when power is very low in cost or in small portable units. As it will stand rougher handling than any of the other forms, the carbon lamp is commonly used with extension cords. Tantalum lamps are finding a considerable use in manufacturing plants, especially where direct current is available, and the tungsten lamp is being extensively adopted for industrial lighting. The latter is by far the most efficient of the incandescent lamps, and where the lamps are protected from excessive vibration or shock, the tungsten lamp gives an exceedingly long burning life. The choice between tantalum and tungsten lamps depends usually on the cost of current and the size of the unit desired. Tungsten lamps are used singly or in groups with metal diffusers or prism glass reflectors, and where there is considerable building vibration, they are provided with spring suspensions.

The types of arc lamps available for industrial illumination include the enclosed carbon, intensified carbon, mercury, luminous magnetites, and flame carbon. Enclosed carbon arcs, both direct and alternating current, are efficient in large units and have a very low maintenance cost. For the higher grades of lighting they are often equipped with diffusers to soften the light and direct it downward at the proper angle. The intensified enclosed arc, which is now available for direct-current multiple circuits, is more efficient than the corresponding capacity of enclosed arc. The flaming arc is now being used to a considerable extent for the lighting of foundries and machine shops where the rooms are high and it is desirable to hang lamps above the crane. The characteristic distribution of the flaming arc, which throws the maximum of light directly downward, particularly adapts it to the lighting of high buildings. Its high power suits it for lighting large areas when hung at a considerable height.

"The remarkable developments of the last few years and the remoteness of ideal efficiency give promise of further development and improvement in illuminants. The importance of these developments in cheapening and at the same time improving the artificial illumination of industrial processes behooves the manufacturer to keep abreast of the times. It should be borne in mind that the first cost of almost every type of electric lamp is relatively small, as compared with the cost of a year's operation, so that the user can afford to take advantage of the developments, even to the extent of throwing out his old lamps and putting in new ones at reasonable intervals."

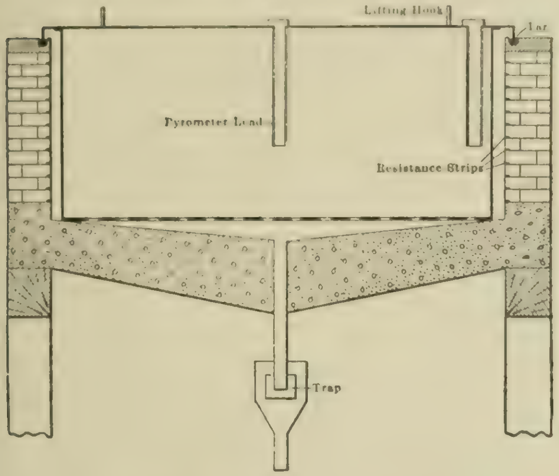
THE ELECTRICAL DISTILLATION OF TURPENTINE.

DATA OF A SUCCESSFUL PROCESS FOR THE EXTRACTION OF BY-PRODUCTS FROM WOOD WASTES.

O. Higman, Jr.—Electrical World.

THE heating effect of the electric current is utilized for a novel purpose in a plant in Vancouver, B. C., in which the distillation of turpentine and other by-products from sawmill wastes is carried out in electrically heated retorts. So far the process has been worked on a comparatively limited scale. The existing plant has a capacity of only two cords of wood wastes per day. It is soon to be superseded, however, by an installation capable of treating 40 cords of wastes per day, according to O. Higman, Jr., who gives a few data of the process in *Electrical World* for February 17.

The plant at Vancouver, which has a capacity of two cords of wood per day, comprises four retorts, with auxiliary condensers and settling tanks. The construction of the retorts is shown in the accompanying diagram. They are heated by a 110-volt current flowing through resistence strips of iron which encompass each retort in the form of a rectangular spiral, adjacent coils being separated by a course of bricks. The retorts are located directly over a storage room so arranged that the resin and pitch drain from the retorts to the barrels in which they are to be shipped.



CROSS-SECTION OF RETORT.

The wood to be treated is charged into iron boxes, 9 feet by 4 feet by 1 foot 2 inches, which are wheeled into the retort room and are placed in the electrically heated brick settings by a travelling crane. The current consumption for each retort ranges from 350 to 400 amperes. Perforations in the bottom of the receptacles allow the pitch and resin to drain off. A bent flange at the top fitting into a groove filled with pitch on the setting forms an effective seal to prevent the escape of vapors or the entrance of air. Each receptacle is equipped with two sets of leads connecting with direct-reading pyrometers, one of which registers the temperature at the outside, and the other the temperature at the center, of the charge.

"Vapors pass from the retort to a jet condenser consisting of an upright copper pipe down which a spray of water is directed, condensing the turpentine and tar oil from the other gases which are allowed to escape. This mixture of water and turpentine or tar oil is collected below the condensers in settling tanks from which water and turpentine, or tar oil, as the case may be, is separately drawn off by means of stop cocks arranged at suitable levels. The temperature of the brickwork when a freshly charged receptacle is introduced is about 250 degrees C. This temperature is maintained electrically for about two hours. During this time the temperature at the center of the charge has risen to 45 degrees C., while the temperature at the outside of the charge has risen to 130 degrees C., the temperature at which turpentine begins to vaporize. The current is now shut off, and heat passes from the brickwork to the charge for a further period of two hours, when the temperature at the outside of the receptacle has risen to 150 degrees C. and that at the center to 205 degrees C. At this stage practically all (90 to 95 per cent) of the turpentine has been removed." The higher temperature at the center than at the outside of the charge is due to the liberation of latent heat from the hydrocarbons undergoing decomposition.

While the turpentine is evaporating, the resin in the wood melts and is drained off through a trap at the bottom of the retort. When the evaporation of the turpentine is completed, the receptacle is removed to another setting where the temperature of the charge continues to rise without further application of electricity. The receptacle is here connected to another condenser by means of a separate pipe, in order to extact the tar oil without fouling the turpentine system. During this part of the run the temperature at the center of the charge rises to 375 degrees C., at which point the tar oil and pitch, or wood tar, are all extracted and nothing but charcoal remains in the receptacle. The receptacle is placed on a sand floor, the sand sealing the perforations and preventing combustion of the charcoal, and the charcoal is allowed to cool for about three hours, after which it is sacked for shipment. The charcoal product is of an exceptionally fine grade, and contains only 0.25 per cent of ash. The turpentine is rated as equal to the best Southern spirits of turpentine.

The amount and kind of the products obtained depend, of course, on the nature of the wood treated. The following table gives the quantities of the various products obtained in the treatment of 40,000 pounds of British Columbia fir.

	Per cord.	
Turpentine	7.5	gallons
Tar oil	18	"
Resin	38	pounds
Charcoal	1,338	"
Pitch	20	"

A plant with a capacity of 40 cords per day is about to be erected. The detailed estimates of the cost of the process and the value of products (Vancouver prices) are given in the tables opposite.

It is believed that still further economy could be gained by utilizing the inflammable gases after extracting the ammonia and acetic acid.

Cost of Production.

	Per cord.
Wood delivered	$2.75
Electricity, $25 per kilowatt-year	1.50
Labor	1.00
Packing and other expenses	3.50
Total cost of production	$8.75

Value of Products.

Turpentine, 6 gallons at 75 cents	$4.50
Tar oil, 20 gallons at 60 cents	12.00
Resin, 60 pounds at 3 cents	1.80
Charcoal, 1,300 pounds at $20 per ton	13.00
Pitch, 20 pounds at 3¼ cents	.65
Total value of products	$31.95

PHOTOGRAPHIC SURVEYING FROM BALLOONS.

A DESCRIPTION OF A METHOD OF TOPOGRAPHIC SURVEYING INVOLVING THE USE OF DIRIGIBLE BALLOONS.

Engineering.

THE development of methods of photographic surveying from balloons, using this term to denote all appliances which move through the air or are held in it, has kept pace with neither the rapid development of photographic surveying on the one hand, nor of flying machinery of various kinds on the other. Geodetically three systems may be distinguished. When separate photographs are taken at intervals, as when the instruments are attached to captive balloons or to kites which are always swaying to and fro in the wind, the direction of the optical axis of the instrument must be determined in each case. When two photographs are taken simultaneously at the ends of a base of sufficient length, real bird's-eye views are obtained which can be combined in a stereo-comparator. The length of the base should be at least 5 yards, an awkward length for a balloon cage except with rigid airships of the Zeppelin type. The most recent system, that of the panorama view, is the invention of an Austrian officer, Captain Scheimpflug, from whose recent lectures before the Physical Society of Frankfort-on-the-Main a brief description of the system is abstracted in *Engineering* for January 28.

"Captain Scheimpflug works with a special camera and other elaborate photographic apparatus of his own design; but he would appear to be able to complete a survey with a small staff and in a very much shorter time, and therefore at much smaller expense, than can be realised with the customary instruments. His panorama camera consists of a central camera with a horizontal plate and seven inclined lateral cameras surrounding the former. The cameras are rigidly connected with one another and the shutters released simultaneously, so that a very large field—he spoke of taking in an angle of 140 degrees—is secured. The first thing to be done is to produce horizontal projections of the inclined negatives. This is accomplished in a special apparatus, and the resulting panorama views show a central heptagon surrounded by seven other trapezoidal photographic sheets; the whole resembles a polygon star with seven arms, the broad bases of the trapezoids lying outward. The diameter of the circle of country represented by this polygon will be about five times the height at which the balloon and the camera were situated at the moment of exposure. In other words, a camera 500 metres above the earth will take in 5 square kilometres, or nearly 2 square miles, and so on.

"In flying over the ground, the surveyor takes photographs at rapid intervals. Thus his photographs will overlap, and it is desirable that they overlap by more than half. The nadirs of successive photographs will be discernible on the same plate, therefore; but it will mostly be easy to fix the positions of these nadirs—that is, the point just underneath the centre of the central camera—on every picture with fair accuracy. If nadir A is in the centre of the first photograph, and nadirs B and C are further to the right, then B will be in the centre of the second photograph, and C in the centre of the third, and the picture can be oriented with the aid of the lines joining those points A, B, C. This orientation would be rigorously correct if the nadirs could exactly be determined. That is not possible, and the central camera may, moreover, not have been quite horizontal at the moment of exposure, so that the angles measured on the panorama view may not rigorously be equal to the angles, as measured by the surveyor below.

"In order to obtain a higher degree of accuracy, as large a number as possible of reference points, prominent objects in the landscape, common to three more or less overlapping panoramic views, are selected. There may be ten or twenty of these reference points. They are numbered; pieces of tracing-paper are placed over the views, and lines are drawn on the paper from the nadirs to the respective points of reference. Thus sets of three rays, diverging from the nadirs and from the points of reference, are obtained. These pieces of paper are then oriented with the aid of the nadirs and superposed, without any regard to the scale, which is still unknown. For the polygons will be similar to one another, but not equal in area, as the balloon may have changed its level in the interval between successive exposures. The superposition will, in general, show that the views do not quite coincide, but that certain triangles of error are left. As a rule, these triangles will have small areas, and coincidence may be secured with the aid of a slight shifting of the three sheets. If not, the one or other of the nadirs will have to be redetermined with all possible accuracy, and the same process gone through. Usually, however, three and more views can be oriented in this way. If it be possible afterwards to fit them into some triangulation net, the scale of the photograph will be known.

"The points of reference further admit of determining the momentary difference in height between a point of reference and the position of the balloon with regard to each of the three plates; that is to say, the actual differences between the levels of the balloon at the three moments of exposure. If this graphical determination is repeated with several points of reference, the balloon level can be fixed with sufficient accuracy. This done, the level differences of the several points of reference in the landscape can finally be ascertained. For any point of reference, which is not situated on the plane of the picture, will appear displaced, when seen obliquely from above, according to the height to which it rises above the plane, and certain proportionalities will reveal that height. This operation is performed with the aid of another apparatus—the zone transformer.

"The final result is a photographic map of the country as seen from above, on which the heights of prominent points will be marked, all originally on a small scale, which can, of course, be magnified. The apparatus is certainly expensive, and the method elaborate. On the other hand, the same outfit will serve for many surveys, and supposing airships to be built for other purposes, their utilisation for survey work would not cause great extra expense, and would not interfere with the other objects aimed at. Captain Scheimpflug concluded his lecture with giving estimates of the surveying of German South-West Africa, a territory nearly three times the size of the United Kingdom. A plane-table survey by a hundred topographers, on the scale of 1 : 25,000, he thought, would occupy 150 years or more and cost, at the lowest, ten million pounds. With the aid of his system, a dirigible, for example, of the Parseval type—rigid balloons are not required—kept at an elevation of about 1,000 metres, the mapping on a scale of 1 : 10,000 might be accomplished in fifteen years, at the expenditure of two million pounds; with a larger balloon (capacity about 6,600 cubic metres), floating at the 2,000-metre level, the survey on a scale of 1 : 20,000 could be accomplished in five-and-a-half years, at a cost of less than three-quarter million pounds. A survey by means of ten captive balloons would be intermediate between the two first-mentioned estimates. These figures are probably somewhat optimistic. It is, however, more and more recognised that the photographic survey affords the best means of systematically following up slow changes in the contour of the land, and that it will therefore receive more general attention. There may be a field for photographic survey from airships, on special occasions, as well as for systematic work in the Colonies."

THE NITRATE DEPOSITS OF CHILE.

A REVIEW OF THE ORIGIN, OCCURANCE, MINING AND COMMERCIAL IMPORTANCE OF THE NITRATE DEPOSITS.

R. A. F. Penrose—Journal of Geology.

THE competition of nitrogenous compounds produced as by-products in coke-oven and gas-producer operation or by fixation of the nitrogen of the atmosphere seems to have little effect on the prosperity of the Chile saltpeter industry. Production continues on an increasing scale and the price, without any of the artificial support which has been supplied by combinations and price agreements in the past few years, shows no sign of serious reduction. An interesting survey of the Chilean nitrate industry is contributed to the *Journal of Geology* for January-February by R. A. F. Penrose; the brief abstract below gives little more than an outline of Mr. Penrose's comprehensive treatment.

The deposits are located in the northern part of the country, in the region lying between 19 and 20 degrees south latitude, and mostly in the provinces of Tarapaca and Antofagasta. The Tarapaca region has been worked for a longer time, and is now worked on a larger scale, than the Antofagasta region, but the latter has great future possibilities. Although the deposits have probably been known from very remote times, nitrate mining on a commercial scale is a comparatively modern industry. The first operations of any importance are said to had been begun in Tarapaca about 1826. During the next fifty years, as new deposits were discovered and as the demand for nitrate increased, the field and the scale of nitrate mining were gradually extended; it was not, however, until the close of the war between Chile and the allies Bolivia and Peru in 1883 that the industry began to approach its present activity. The treaty of peace gave to Chile control of all the known nitrate deposits on the west coast of South America. The Chileans themselves became largely interested in the nitrate industry and capital poured into the country from England, Germany and the United States. The industry is now largely in the hands of English companies. Although Americans were among the pioneers, their operations are small compared with those of the English, Germans and Chileans.

The nitrate deposits are found at intervals in an arid region known as the pampa, at an elevation of 2,500 to 5,000 feet above the sea, which runs north and south in a long narrow belt for almost five hundred miles between the Andes on the east and the Coast Range on the west, from a few miles to over one hundred miles inland. It is of a generally flat or undulating character, studded with small rounded hills, some of them of considerable height. Its surface is dry and sandy and vegetation is almost totally absent. Rain is very rare, droughts of three or fours years' duration being of frequent occurrence. The streams flowing westward from the Andes rapidly evaporate or sink below the surface when they reach the pampa; only a few reach the sea on the surface. Occasionally in seasons of great floods the pampa is covered with water over large areas but the normal condition of the region is one of great aridity. The very presence of the extensive deposits of soluble nitrates is evidence of the extreme dryness of the region. The surface of the pampa is composed mostly of sand, clay and gravel, with more or less rounded rock masses scattered over it, and frequent deposits of saline materials. Isolated hills and knolls of stratified and igneous rocks, similar to many of the rocks found in the adjacent mountain ranges, frequently protrude through the loose materials, and doubtless rocks of like character underlie the pampa. The surface materials are probably of post-Tertiary age and represent an old sea bottom formed by the deposition of sediments in a now extinct inland sea.

The pampa has a gentle slope from east to west; the saline materials occur at its lowest point, that is, along the western border. The deposits form beds varying in thickness from a few inches to many feet. The beds lie practically on the surface, though they are sometimes capped by earthly materials to a depth of some feet. Most of the deposits consist of common salt or of nitrate or of a mixture of the two. Other saline materials occur more sparingly. Although both common salt and nitrate occur in immense quantities, the salt is by far the more abundant and covers flats many square miles in area. The beds have not been extensively explored, the salt being used only for local consumption.

The nitrate deposits are far more important commercially. While the salt flats are usually in the very bottoms of the basins, the nitrate deposits are usually on a little higher ground. The nitrate beds are of variable thickness over even small areas; in one spot there may be several feet of the material, while within a few yards there may be only a few inches or none at all. A thickness of 1 to 1½ feet is common, of 2 to 3 feet not unusual, of 4 to 6 feet very unusual. They are usually covered by a capping composed of sand, clay, gravel and rock fragments varying in thickness from a thin coating to 40 feet. This capping is more or less indurated though the surface often shows from a few inches to a few feet of loose, wind-blown material. In some places there is a sharp line of demarcation between the capping and the nitrate; in others they seem to represent one and the same deposit, rich in nitrate at the base and poor in nitrate above, a condition which may be due to improverishment by leaching during the rare periods of flood or rainfall. Underlying the nitrate is an earthy material of a brown or buff color, and below this again is a great series of interbedded sands, clays and gravel which underlie the broad expanse of the pampa.

The nitrate occurs in the form of sodium nitrate with the formula $NaNO_3$, though very small quantities of other nitrates are sometimes found with it. The deposits seldom contain pure sodium nitrate; rarely are they 70 per cent pure. Crude nitrate containing 25 per cent of sodium nitrate is considered a fair grade of raw material and 50 per per cent is considered a high nitrate content. The impurities are sand, clay, gravel and rock fragments, with a very variable admixture of saline materials. The saline impurities are mostly common salt, sodium sulphate and calcium sulphate. In addition there occur sodium and calcium borates, as well as carbonate, chloride and other salts of calcium, various salts of aluminium, magnesium, potassium and ammonium, and a small but very constant quantity of sodium iodate. Bromine compounds and small quantities of other materials are sometimes, though rarely, present. The iodine in the crude nitrate is very important commercially, though it represents generally only a fraction of 1 per cent of the mass. It is recovered as a byproduct in refining the nitrate. The borates, which occur mostly in the form of the hydrous borate of sodium and calcium or of calcium alone, have been produced in varying quantities at different times, often in very important amounts.

Many suggestions have been advanced to explain the origin of the nitrate deposits, the discussion of which involves chiefly the source of the nitrogen. Its derivation from organic matter, and especially from guano, seems the most probable hypothesis. The coast of Chile has been gradually rising in recent geological times and the pampa region was once part of the ocean bottom. During this elevation the pampa region probably passed in succession through the conditions of an open gulf, gradually becoming more and more separated from the ocean, and later of an inland sea or a series of salt lakes. Guano beds were doubtless deposited along the borders of these waters. Guano consists largely of nitrogenous materials, phosphates and water, and while the nitrogenous materials are not originally in the form of nitrates, under suitable conditions they pass eventually into that form through the agency of certain bacteria. It seems probable that the nitrates of Chile were mostly produced in this way. Subsequently they were carried down into the waters of the basin and became mixed with the other saline materials there. As the waters gradually evaporated, the concentration of the solution increased until finally deposition of the salts began along the border and on the bottom. Eventually the whole body of water disappeared and the dry desert pampa with its deposits of nitrates, common salt, and other materials alone remained. The occurance of the nitrate in the form of sodium nitrate is probably due to the abundance of sodium salts in the region. The location of the saline deposits along the western edge of the pampa may be due to one or both of two causes, the final collection of the waters along the western border on account of the slope of the bottom, or a leaching process which has transferred materials deposited elsewhere to the location of the present deposits. The iodine was probably obtained from the decay of marine plants.

Mining in the nitrate regions is done in surface openings, usually in isolated pits or short trenches on the spots where the nitrate is richest. In some few cases, where the capping is hard and compact, or very thick, small underground workings in the form of caves have been formed, but these are the exception. Many properties have been worked over several times, lower-grade material being taken each time. In the early days, only the richest of the deposits were worked and only crude nitrate running as high as 40 or 50 per cent in sodium nitrate was mined. The average of crude material now mined in the Tarapaca region would run, perhaps, below 25 per cent in nitrate, and in certain places crude nitrate running as low as 10 per cent is utilized in admixture with higher-grade material.

The refining process consists of coarse crushing and separating the nitrate from its impurities by leaching with hot water. The refined product usually contains about 95 per cent of sodium nitrate, which is taken as the standard of purity, although a higher-grade product is sometimes made for special purposes. The method used in extracting the nitrate is very crude, and the average loss in refining in the Tarapaca region is said to be about 35 per cent. The iodine is obtained from the solution after the nitrate has been taken out by concentration of the mother liquor and treatment with sodium sulphites. The black precipitate is sublimed and condensed to the black scaly flakes of crystalline iodine. Water for the refining plants is obtained from wells, often in considerable quantities at depths of from 50 to 100 feet, or in a few cases by piping from Andean streams.

For a large part of the time in recent years most of the large nitrate producers have been in a combination which limits the output of refined nitrate and apportions to each company the amount that it may produce annually. This combination has been broken up more than once by dissentions among the producers, and as late as March, 1909, after it had been in force for several years it was again broken. Recent reports, however, are to the effect that strong efforts are being made to renew it. The price of iodine is kept up in the same way. An organization is maintained to promote the use of nitrate, especially in agriculture, and agents are kept in all the large countries of the world. As a result, the consumption of nitrate is rapidly increasing. The production in 1830 was only 8,348 long tons. By 1900 the annual output had risen to 1,473,091 long tons, by 1907, to 1,780,818 long tons, and from April 1, 1908, to March 31, 1909, the production was about 1,808,986 long tons. The value of nitrate varies from year to year but the price in New York or European ports in recent years has ranged between $40 and $50 per long ton.

Estimates of the probable life of the nitrate deposits differ very widely, some predicting exhaustion in twenty-five to thirty years, others showing that the deposits will last for three or four hundred years. Many of those who predict a short life for the nitrate fields do not allow anything for future new discoveries of nitrates in northern Chile, which has not been thoroughly explored and where the probability of the existence of nitrate deposits is very great. Low-grade materials are gradually accumulating in immense quantities and may be used in the future when more economical methods are introduced. By the use of these materials, together with the aid of possible new discoveries of nitrate, Chile will doubtless be able to supply the world with nitrate for very many years to come. The nitrate of Chile is used for a large numbers of different purposes, but by far the largest consumption is for artificial fertilizer. One of its earliest uses, and still a source of large consumption, is the manufacture of niter, or potassium nitrate, for gunpowder. The nitrate of Chile is used in the manufacture of nitric acid and also, though on a much smaller scale, for many other chemical purposes.

COLOR BLINDNESS.

THE DEFECTS OF PRESENT METHODS OF TESTING FOR COLOR BLINDNESS IN MARINE AND RAILWAY SERVICE.

F. W. Edridge-Green—Royal Society of Arts.

COLOR blindness plays an important part where visual signals are employed, as at sea and on railways, and the proper ability of those engaged in navigation or train operation to perceive correctly such signals is of such prime necessity that the examination of sailors and railway employees with this end in view is generally provided. Nevertheless, the underlying theory of color vision is none too perfectly understood, though to determine whether it is abnormal or deficient, there are various tests applied. According to Dr. F. W. Edridge-Green, whose recent comprehensive paper on the subject before the Royal Society of Arts is published in the *Journal* for February 11, the various tests ordinarily used for color blindness are faulty, and after developing a theory of vision and color vision, he proceeds to formulate new and more adequate tests, and to show the shortcomings of the familiar method where worsted of various colors is submitted to the person whose color vision is under test. Dr. Edridge-Green states that "cases of color blindness may be divided into two classes, which are quite separate and distinct from each other, though both may be present in the same person. In the first class there is light as well as color loss. In the second class the perception of light is the same as in the normal sighted, but there is a defect in the perception of color." The color blind may be classified in accordance with the number of colors which they see in the spectrum. If the normal sighted be designated hexachromic, those who see five colors may be called pentachromic; those who see four, tetrachromic; those who see three, trichromic; those who see two dichromic; and the totally color blind, monochromic. There are many degrees included in the dichromic, in which there may or may not be a neutral band which is widest in those cases approaching most nearly to total color blindness. Thus, in such a case only red and the extreme violet may appear to such a dichromic, while in the trichromic class which can see red, green and violet, for example, yellow may be seen as red-green and blue as violet-green. All above the trichromic class may be grouped with the normal sighted for practical purposes, as they are not dangerously color blind and can always distinguish railway and marine signal lights correctly.

In testing for color-blindness it is desirable to know whether the defect is present or not, as by the use of a spectrometer, and then when the inquiry is made for some practical purpose, for instance, to determine whether those employed in the marine and railway services are able to recognize and distinguish between the standard red, green, and white lights, some simpler and less exact method must be used. Furthermore it is necessary to ascertain that the person being tested thoroughly understands what is meant by color, and the individual characteristics of red, green, and white respectively. Too little attention has been paid to this in constructing tests for color blindness and those who have had much practical experience in testing for this defect are aware of the ignorance which exists among uneducated persons with regard to colors. Many are under the impression that every shade of a color is a fresh color, and others have the most novel ideas with respect to color. It is necessary that a sailor or engine driver should be able to recognize a red, green, or white light by its character of redness, greenness, or whiteness respectively; that is to say, the examinee must have definite ideas of color and be able to reason with respect to them.

In constructing a test for color blindness, we must not forget the element of color ignorance, because an engine driver or sailor has to name a colored light when he sees it, not to match it. The ordinary color names red, blue, yellow and green, form excellent bases for classification. The engine-driver is told that red is a "danger" signal, green a "caution" signal, and white an "all right" signal. Therefore it is very necessary that he should know what is meant by these colors. The real object of tests for color blindness should be to exclude:

1.—Those who see three or less colors in the spectrum.

2.—Those who while being able to perceive a greater number of colors than three, have the red end of the spectrum shortened to a degree incompatible with their recognition of a red light at a distance of two miles; and

3.—Those who are unable to distinguish between the red, green, and white lights at the normal distance through insensitiveness of the retinal-nervous apparatus when the image on the retina is diminished in size.

While the dichromic regard green and red as almost, but not quite, identical, yet they are able to recognize different colors and may be able to name them with accuracy. Then all colors have not a similar degree of luminosity and it is here that many tests fail. Persons belonging to the second class should be excluded as here is a very practical form of weakness. The rays of red at the extreme left of the spectrum are the most penetrating, as may be seen by looking at a light or the sun in a foggy day, or through several thicknesses of neutral glass. The third class of color blind present interesting tests as there is no reason to exclude a man who cannot distinguish between green and gray wool, but can distinguish between standard red and green lights under service conditions, and the latter should be the basis of a practical test. Such a test has been devised by Dr. Edridge-Green, and consists of a lantern with slides containing standard red and green glass. By means of certain kinds of neutral glass the intensity and character of the light can be changed without the knowledge of the candidate. These glasses act on the colored lights like a mist or fog on distant lights, and when their intensity is diminished, they can only be distinguished with great difficulty by the color blind, while the normal sighted readily recognize colored lights even under such conditions. The neutral glasses used represent fog, the ground glass mist and the ribbed glass rain; the test is eminently practical.

The author objects to the wool test which is the official test of the British Board of Trade, first on the score of the difficulty of obtaining correctly colored wools which are both uniform and permanent, and at the same time free from other differences that would afford marks of distinction to the color blind. Furthermore the relative luminosity of the colors of wools is very great, and forms a distinguishing point to the color-blind. "An ordinary red-green color blind will not put a yellow wool with a green or red one, but he will put yellow glass with green or red glass.

"The test colors used are a light-green and a light shade of rose. A red is also used as a confirmatory test. A pure green is one of the worst colors to choose for a first test. If the blue-green be removed, color-blind persons may easily pass through the list without detection."

"Whom are we to reject by this test? If we reject all the (so-called) partially red and green blind, we shall reject many persons who are practically competent. If we only reject the (so-called) completely red or green blind, we shall allow many persons who are dangerously color-blind to officiate as signal men." The test is more theoretical than practical, and in the author's experience an ignorant pentachromic or tetrachromic color-blind (that is, a person who is partially color-blind, but not color-blind to an extent necessitating his rejection) is more likely to fail than an educated dichromic (red-green color-blind). A person with central scotoma or insensitiveness to color when occupying a small portion of the field of vision, will escape detection if examined by this test.

"As a light at a distance occupies the central portion of the field of vision, these persons will be found to recognize colors when close to them, but not when they are at a distance. The red end of the spectrum may be considerably shortened, so much so that a person may scarcely be able to distinguish red from black. It is obvious that this will not prevent him from matching a light green with other wools. It is not by any means an efficient test. We cannot reject by it those persons who would be dangerous as sailors or engine drivers, and only those persons." It is not a difficult task to instruct a red-green color-blind to meet this test successfully and many dangerously color-blind men have been passed by it. In the Board of Trade report for 1908 it is stated that of those who were rejected by the wool test and who appealed over 53 per cent. were found to be normal sighted, and to have been rejected wrongly. Dr. Edridge-Green believes that the test has been a failure and that the facts in connection with it should be carefully investigated.

THE HUDSON BAY RAILWAY.

A BRIEF OUTLINE OF THE PROJECT AND AN ESTIMATE OF THE COST AND TRAFFIC POSSIBILITIES OF THE HUDSON BAY ROUTE.

Engineering News.

THE establishment of a port on Hudson Bay and the construction of a railway thereto to assist the development of the great Canadian Northwest is a very old scheme. There are grave objections to the project, all based on the high latitude of the entrance to Hudson Bay, which include the short season of navigation (three to four months) and the difficulties and dangers of navigation due to ice. The entrance of Hudson Straits into Hudson Bay lies far north of latitude 60 degrees, and even during the open season navigation is endangered by ice floes, fogs and contrary currents. The Canadian Government, however, now stand committed to the work of building the railway and the Minister of Railways has promised that construction will be pressed with all possible speed. A brief review of the project is taken from an article in *Engineering News* for March 3.

The chief advantage of the Hudson Bay route lies in the fact that the distance from Fort Churchill to Liverpool (passage north of Ireland) is about

3,200 miles, as compared with 3,000 miles Montreal to Liverpool. Until within the past few years the Hudson Bay Railway has been projected as part of a commerce route starting from Winnipeg, the starting point of all rail and rail-and-lake routes to the seaboard. With the great development of the Northwest and its railway systems, however, an important change has been made in the project by which Winnipeg will be eliminated and freight will be shipped by more direct rail routes from the northwest districts to Hudson Bay. The starting point now proposed for the Hudson Bay Railway is "The Pas" on the Saskatchewan River, which is now reached by the Canadian Northern Railway and to which other lines are projected.

During the winter of 1908-9, lines were surveyed from "The Pas" reaching both Fort Churchill and Port Nelson on Hudson Bay. "For the Fort Churchill route (477 miles) the first 120 miles would be comparatively level country, with a considerable amount of swamp; the next stretch of 120 miles would be in granite country, involving a number of rock cuttings. The heaviest work would be in the third stretch of 120 miles, which includes the rise between the basins of the Nelson and Churchill rivers, with heavy rolling country which necessitates considerable development of the line to keep the prescribed grades. On the fourth section the earthwork will probably be light, but the crossing of the tundra or low barren swamps bordering on the bay (70 miles) may prove more expensive than the easy profile would indicate. The grades are 0.4 per cent. against northbound traffic and 0.6 per cent. against southbound traffic. The curvature averages 10 degrees per mile. The Port Nelson route (410 miles) diverges from the other route near Split Lake, about 120 miles from "The Pas"; it does not strike the barren lands, but is in timber country throughout. The maximum grades are the same, but the curvatures averages only 5.5 degrees per mile.

"The Churchill route would have to be operated in four locomotive divisions of about 120 miles each; but on the Port Nelson route (owing to the easier grades) the engines could operate three divisions of 135 miles each. Thus five engine terminal facilities would be required on the former and four on the latter route." The estimated costs of the two routes provide for passing tracks and telegraph stations at intervals of five miles, water stations at intervals of 15 miles, and roundhouse and shop accommodation sufficient to care for the equipment necessary for 32 freight trains and one fast passenger train every 24 hours. The estimated cost of the Fort Churchill route is $19,108,672; of the Port Nelson route, $16,426,340. The allowance for equipment is $9,000,000 in each case. For harbor work $6,675,000 is allowed in the case of the Fort Churchill route and $5,065,000 in the case of the Port Nelson route, making the total estimates, respectively, $34,783,672 and $30,491,340.

"The Port Nelson route is considered the preferable; it is shorter, the construction work is easier and the port conditions are better. A fair proportion of the route is also considered available for settlement, while there is no probability of settlement on the Churchill route north of its junction with the Port Nelson route."

According to a report by M. J. Butler, Deputy Minister of Railways and Canals, the whole of Alberta and Saskatchewan with the exception of about 11,000 square miles in the latter province will be tributary to the Hudson Bay route. Locomotives of the Mallet type with a hauling power of at least 4,000 tons of pay load are to be employed. Allowing 16 loaded trains per day for 30 days, it is estimated that 64,000,000 bushels of wheat will be moved per season, requiring 135 to 140 ships if two trips are allowed to each ship. Other sources of traffic possible to the line are the exportation of cattle, package freight to and from Europe and an import coal trade with Nova Scotia. The possible saving in grain traffic is estimated at 5 cents per bushel, assuming that insurance and freight rates are equal at Port Nelson and Montreal.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING..............	Page 119	MECHANICAL ENGINEERING........	Page 135
ELECTRICAL ENGINEERING.........	" 126	MINING AND METALLURGY.........	" 146
INDUSTRIAL ECONOMY............	" 132	RAILWAY ENGINEERING...........	" 152
MARINE AND NAVAL ENGINEERING.	" 133	STREET AND ELECTRIC RAILWAYS...	" 156

CIVIL ENGINEERING.

BRIDGES.

Abutments.

A Pier Type of Abutment for Highway Bridges. Illustrates and describes abutments adopted on the Barge Canal. 1000 w. Eng Rec—Feb. 5, 1910. No. 11482.

Bascule.

Bascule Bridge at Copenhagen. Illustrated description of the new bridge, of the double-bascule type, over the harbor channel. 1000 w. Engr, Lond—Feb. 4, 1910. No. 11622 A.

Emergency Repairs to a Bascule Drawbridge Over the Chicago River; Chicago Terminal Transfer Ry. F. H. Avery. Explains the damage caused by the bridge being struck by a steamer and describes the repairs. Ills. 2500 w. Eng News—Feb. 3, 1910. No. 11411.

See also Timber, under BRIDGES.

Cantilever.

Great Bridge Over the Red River in Indo-China. Illustrated description of a fine cantilever railroad bridge, erected by

French engineers. 900 w. Sci Am Sup—Feb. 5, 1910. No. 11406.

Erection.

Erection Appliances for the Belly River Viaduct at Lethbridge, Alberta. Illustrates and describes the mechanical appliances used in erecting this high viaduct. 1200 w. Eng News—Feb. 24, 1910. No. 11874.

Floors.

The Cost of Bridge Floors: Gives a comparison of three types of jack arch floor construction as to economy. 3500 w. Engr, Lond—Jan. 28, 1910. No. 11541 A.

Masonry.

See Repairing, under Bridges.

Moving Loads.

A New Moment Table. C. R. Young. Gives a new table with the object of shortening calculations for shear and moment due to moving locomotive and train loads. 1000 w. Ap Sci—Jan., 1910. No. 11825 C.

Quebec.

The Design for the New Quebec Bridge. Line drawings and criticism of the proposed plans. 1500 w. Sci Am—Feb. 12, 1910. No. 11549.

Reinforced Concrete.

Design and Cost of Reinforced-Concrete Highway Bridges. A. N. Johnson. Abstract of a paper presented at meeting of the Ill. Soc. of Engrs. & Surv. Gives data concerning work done in 1909. 2200 w. Eng News—Feb. 10, 1910. No. 11521.

Some Cost Data for Reinforced-Concrete Highway Bridges. A. N. Johnson. Read before the Ill. Soc. of Engrs. & Surv's. Explains what control the State Highway Commission in Illinois has over bridge work, and gives cost data of concrete bridges built in 1909. 3000 w. Eng Rec—Feb. 5, 1910. No. 11478.

Method and Cost of Reinforced Concrete Highway Bridge Construction. Under the Direction of the Illinois Highway Commission. Rearranged from a paper by A. N. Johnson, read before the Ill. Soc. of Engrs. & Surv. Gives reasons why nearly all their concrete bridges are of the girder type and information concerning them. 3000 w. Engng Con—Feb. 2, 1910. No. 11424.

The Construction of the Evanston Subway Bridges, Chicago, Milwaukee & St. Paul Railway. E. O. Greifenhagen. Illustrates and describes the construction of the piers and abutments and of the slabs. 3500 w. Eng Rec—Feb. 5, 1910. No. 11477.

The Design of the Evanston Subway Bridges, Chicago, Milwaukee & St. Paul Railway. E. O. Greifenhagen. An illustrated detailed description of the design of these bridges, considered under the headings of piers, abutments, and slabs. 3000 w. Eng Rec—Jan. 29, 1910. No. 11315.

The Governor Reynolds Reinforced-Concrete Bridge, Province of Albay, Philippine Islands. Oliver D. Filley. Illustrated description of a bridge built by American engineers. 1500 w. Eng News—Feb. 17, 1910. No. 11647.

Concrete Arch Railway Bridge over the Ulster (Eisenbahnbogenbrücke aus Beton über die Ulster). Herr Winter. Illustrated description. 2000 w. Beton u Eisen—Jan. 28, 1910. No. 11907 D.

Repairing.

Repairs to a bridge on the Boves-Ailly-sur-Noye Line (Note sur la Réfection du Pont au-dessus du Chemin de grande Communication No. 90 de Boves à Ailly-sur-Noye). H. Bouchard. Illustrated description of repairs to a masonry arch. 1500 w. Rev Gen d Chemins de Fer—Jan., 1910. No. 11712 G.

Steel.

The Liao River Railway Bridge, Manchuria. Illustrated detailed description of the erection by Chinese workmen of a 20-span girder bridge on concrete piers. 2000 w. Engng—Jan. 21, 1910. No. 11386 A.

Boylston Street Bridge, Boston, from 1888 to the Present Time. Frederic H. Fay, Charles M. Spofford and John C. Moses. An outline of the construction, history, destruction, and reconstruction of a bridge subjected to locomotive fumes and increasing street car loads. Ills. Discussion. 12800 w. Jour Assn of Engng Socs—Dec., 1909. No. 11959 C.

Types of Highway Bridges. F. Barber. First of a series of articles giving illustrations and describing the writer's idea of the kind of bridge suitable for particular locations. 1500 w. Can Engr—Feb. 18, 1910. Serial. 1st part. No. 11805.

The Calculation of the Vehicle and Foot Ways of Steel Highway Bridges (Beitrag zur Berechnung der Fahrbahn und Fusswege eiserner Landstrassenbrücken). W. Schulz. Mathematical demonstration of method. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 12, 1910. No. 11912 D.

The Beeringen Bridge (Le Pont de Beeringen). A. Vierendeel. Mathematical demonstration of the method of design of a girder bridge of a new type. Ills. 9000 w. All Indus—Jan., 1910. No. 11726 D.

Timber.

The Fosdyke Bridge. Illustrates and describes the old timber bascule bridge over the river Willand, soon to be replaced by a steel swing bridge. 800 w. Engr, Lond—Feb. 11, 1910. No. 11846 A.

Trestles.

The Albemarle Sound Trestle of the Norfolk & Southern Railway. F. L. Nicholson. Map and illustrated description of a pile trestle having two large movable spans for the accommodation of navigation, and five fixed spans. 2000 w. Ry Age Gaz—Feb. 25, 1910. No. 11952.

Viaducts.

See Erection, under Bridges.

CONSTRUCTION.

Beams.

Deflection of Beam Uniformly Loaded for Part of Its Length. George E. Barrett. Mathematical determination. 300 w. Mach, N Y—Feb., 1910. No. 11346 C.

Columns.

Proportioning Latticed Columns by Weight per Foot. Benton Lattin. Discusses the influence of the lacing ratio, and of the length ratio, and the effect of diaphragms. 1000 w. Eng News—Feb. 24, 1910. No. 11878.

Concrete.

A Concrete House with Untreated Surface. Illustrated description of a house at Ocean City, N. J., especially advocating the untreated walls. 3000 w. Cement Age—Feb., 1910. No. 11806.

Concrete Work in the Chelsea Dock Improvements, New York City. Illustrated description of the great wall of reinforced concrete recently constructed along the North River from Little West 12th to 23d street. 700 w. Cement Age—Feb., 1910. No. 11807.

Concrete Construction on the Panama Canal. Brief illustrated description of methods used in handling the concrete. 800 w. Sci Am—Feb. 19, 1910. No. 11650.

Concrete Blocks.

Industrial Chimneys and Water Towers of Concrete Blocks. H. Prime Kieffer. Illustrations of work in Belgium, describing the system invented by M. Dumas. 1200 w. Sci Am—Feb. 19, 1910. No. 11651.

See also Shafts, under MINING AND METALLURGY, Mining.

Cost Systems.

See same title, under INDUSTRIAL ECONOMY.

Earthwork.

See Construction, under RAILWAY ENGINEERING, Permanent Way and Buildings.

Fireproof.

Fire Protection in San Francisco Under the New Building Law. A summary of the fireproofing and fire-protection provisions. 2500 w. Eng News—Feb. 10, 1910. No. 11515.

The Fire Tax and Waste of Structural Materials in the United States. Herbert M. Wilson and John L. Cochrane. An investigation of materials used in construction work, giving statistics of interest. 8000 w. U S Geol Surv—Bul. 418. No. 11698 N.

Floors.

Floor Construction Over Large Halls in High Buildings (Deckenkonstruktionen für Saalbauten in Etagenhäusern, insbesondere bei Hotelbauten). O. Leitholf. Gives a number of examples of floors over large rooms. Ills. Serial. 1st part. 3000 w. Deutsche Bau—Jan. 5, 1910. No. 11773 B.

Foundations.

See Piling, under Construction.

Hydraulic Filling.

Methods and Cost of Hydraulic Filling at Cairo, Ill. Jean M. Allen. Describes notable work. Ills. 2000 w. Engng-Con—Feb. 16, 1910. No. 11659.

Piling.

Interlocking Steel and Concrete Pile Construction for Seawalls and Foundation Work. Illustrated description of this system as used in Chicago. 1400 w. Eng News—Feb. 3, 1910. No. 11408.

Concrete Pile Foundation for the Evansville Filters. F. H. Stephenson. States the conditions and describes the plan and methods adopted. Ills. 1500 w. Eng Rec—Feb. 19, 1910. No. 11685.

Reinforced Concrete.

Industrial Applications of Reinforced Concrete. M. M. Sloan. This third article of a series continues the discussion of structural details of roofs, skylights, stairs, etc. Ills. 1200 w. Engineering Magazine—March, 1910. No. 11976 B.

Uses of Reinforced Concrete in Railway and Power House Work. F. W. Scheidenhelm. An outline of the possibilities of this material in certain fields of construction work. Ills. 3500 w. Elec Jour—Feb., 1910. No. 11998.

Railway Station Platform Roofs in Reinforced Concrete (Bahnsteigdächer aus Eisenbeton). Herr Francke. Describes a number of types of construction used on the Prussian State Railways. Ills. 1500 w. Deutsche Bau—Jan. 12, 1910. No. 11774 B.

What Consideration Should Be Given to Continuity in Reinforced Concrete Beams and Slabs. M. E. Thomas. Discusses the reason for the variation existing in present practice of calculating binding moments and what are the theoretical moments that would guide a designer. Ills. 1000 w. Engng-Con—Feb. 23, 1910. No. 11871.

A Condition of Economy in Reinforced-Concrete Construction (Note sur une Condition d'Economie du Béton armé). A. Detœuf. Mathematical discussion of economy in reinforcement. Ills. 3300 w. Tech Mod—Jan., 1910. No. 11717 D.

The Calculation of Vierendeel Beams (Beitrag zur Berechnung von Vierendeelträgern). A. Ostenfeld. Mathematical. Ills. 7000 w. Beton u Eisen—Jan. 28, 1910. No. 11908 D.

The Calculation of Concrete Beams with Spiral Reinforcement (Zur Berechnung der Eisenbetonbalken mit spiralarmierter Druckzone). Paul Frei. Mathematical discussion. Ills. 1200 w. Zeit d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11794 D.

Graphical Design of Continuous Beams (Beitrag zur graphostatischen Behandlung Kontinuierlicher Träger). B. Löser. Mathematical discussion and tabular data. Ills. 4000 w. Beton u Eisen—Jan. 7, 1910. No. 11905 F.

See also Stacks, under Construction; Aqueducts, under Water Supply; and Timbering, under MINING AND METALLURGY, Mining.

Retaining Walls.

Design of Retaining Walls for the Steptoe Smelter. S. Severin Sörensen. Illustrated description of the standard design used in constructing this large plant in Nevada. 1000 w. Eng Rec—Feb. 19, 1910. No. 11680.

Specifications.

Precarious Expedients in Engineering Practice. John Hawkesworth. Describes methods of preparing plans and specifications and the awarding of contracts, exposing facts and suggesting remedies. 5000 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11956 E.

Stacks.

Reinforced Concrete Chimney Construction. Ernest R. Matthews. Abstract of paper before the Concrete Inst. Considers the advantages of this material, the erection, methods of calculating stresses, effect of excessive heat, etc. 2800 w. Surveyor—Jan. 21, 1910. No. 11381 A.

Methods of Putting a Reinforced Concrete Jacket on a Cracked Chimney. Illustrated description of work at New Haven, Conn., consisting of molding a jacket 5-ins. thick about a cracked and leaky chimney. 900 w. Engng-Con—Feb. 16, 1910. No. 11658.

See also Concrete Blocks, under Construction.

Steel.

A Large Steel Frame Rolling Mill Building. Illustrated detailed description of special structural features of a recent addition to the Jones & Laughlin works, Pittsburgh, Pa. 2500 w. Eng Rec—Jan. 29, 1910. No. 11314.

The Ritz-Carlton Hotel. Plans and description of this steel-frame structure in New York City, having 4 stories below and 15 above street level. 1200 w. Eng Rec—Feb. 12, 1910. No. 11586.

Tunnels.

Tunnels, Particularly Subaqueous. R. B. Woodworth. Gives a brief historical review of tunnels, their classification; illustrating and describing methods of construction, especially of subaqueous work. 22500 w. Pro Ry Club of Pittsburgh—Dec. 22, 1909. No. 11814 C.

The New York Tunnel Extension of the Pennsylvania Railroad. North River Division. Charles M. Jacobs. An outline of the scheme of bringing the Penn. R. R. and Long Is. R. R. into N. Y. City, recording leading features on the work of this division. Ills. 7500 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11957 E.

See also same title, under Water Supply.

MATERIALS OF CONSTRUCTION.

Cement.

Experiments on the Coarser Particles in Cement. George Sydney Brinckley. A report of tests made giving deductions. Ills. 1500 w. Eng Rec—Feb. 19, 1910. No. 11681.

Concrete.

The Scientific Practice of Concrete. Rolf R. Newman. On the development of this material and its present use. 900 w. Cement Age—Feb., 1910. No. 11808.

The Coefficient of Elasticity of Concrete in Shear. Investigates the deflection due to bending, and gives computation for determining the coefficient of elasticity. 1000 w. Cement—Feb., 1910. No. 11802 C.

Tests on the Permeability of Concrete. F. M. McCullough. Reports a series of tests made to determine the efficiency of some of the commercial compounds used for waterproofing concrete. Ills. 4000 w. Wis Engr—Feb., 1910. No. 12007 D.

Tests of Concrete Columns Made Under Building Conditions. H. C. Berry. Illustrated description of tests made by the Civil Engng. Dept. of the Univ. of Penn., discussing results. 2500 w. Eng Rec—Feb. 19, 1910. No. 11679.

The Destruction of Concrete by Hydrogen Sulphide Gas (Betonzerstörung durch Schwefelwasserstoffgas). Erich Stephan. A discussion of the chemical reactions by which concrete is injuriously affected by hydrogen sulphide fumes. 3000 w. Beton u Eisen—Jan. 7, 1910. No. 11906 F.

Steel.

Some Deductions from Marburg's I-Beam Tests. A critical analysis by C. J. Tilden of certain facts reported in connection with recent tests of steel I-beams, with reply by Edgar Marburg. Ills. 2500 w. Eng News—Feb. 24, 1910. No. 11881.

Timber.

The Protection of Submarine Structures. Gen. W. A. Jones. Considers preventive measures against living forms and rust in submerged structures. Ills. 2200 w. Engineering Magazine—March, 1910. No. 11980 B.

The Forest Products Laboratory—Its Work and Equipment. McGarvey Cline. An account of a laboratory for studying problems for eliminating waste and bringing about greater economy in the use of wood. 2200 w. Wis Engr—Feb., 1910. No. 12006 D.

Timber Preservation.

Treating Timber with Crude Petroleum. C. Marshall Taylor. Abstract of a paper read before the Wood Preservers' Assn. A brief résumé of the crude petroleum treatments. 800 w. Eng News—Feb. 3, 1910. No. 11412.

Economical Wood Preservation. Robert Hays. A report of tests to obtain figures relating to the comparative absorption of creosote when the treatments were commenced with hot baths of petroleum and creosote; also the use of salt-water. 1800 w. Ry Age Gaz—Jan. 28, 1910. No. 11303.

MEASUREMENT.

Surveying.

Surveying the Public Land of the United States. H. W. MacFarren. Explains the method of surveying and subdividing the public land. 3500 w. Min & Sci Pr—Jan. 29, 1910. No. 11447.

MUNICIPAL.

Drainage.

Design and Construction of Open Ditches to Reduce Maintenance with a Description of Methods of Maintenance and Some Costs. E. H. Cowan. Read before the Ill. Soc. of Engrs. & Surv. 1800 w. Engng-Con—Feb. 2, 1910. No. 11426.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Describes special street-cleaning services in England. 2500 w. Munic Engng—Feb., 1910. No. 11994 C.

The Collection and Disposal of Refuse in the City of Boston, Mass. Concerning the recommendations of a special commission, with consideration of present methods and costs. 4500 w. Eng News—Feb. 10, 1910. No. 11520.

Roads.

The Dust-Nuisance in Australia. An account of the conference of municipalities convened at Melbourne with the object of discussing the prevention or abatement of the dust-nuisance. 5500 w. Surveyor—Jan. 28, 1909. No. 11531 A.

Bituminous Highway Construction. Clarence A. Kenyon. Read before the Indiana Engng. Soc. Reviews what has been accomplished by experimenters. 2500 w. Munic Engng—Feb., 1910. No. 11996 C.

The Use of Tar for Road-Making and Repairs. William Wade. Read before the Inst. of Munic. Engrs. States present requirements, and discusses methods of using tar as a binder, favoring tar grouting as giving the best road for mixed traffic. 2500 w. Surveyor—Jan. 21, 1910. Serial. 1st part. No. 11382 A.

Tar as Applied to the Surface Treatment of Roads. Hervey J. Skinner. Read before the Am. Gas Inst. Also discussion. Gives results of an investigation carried out at the Little Laboratory, Boston. 7500 w. Am Gas Lgt Jour—Feb. 19, 1910. No. 11556.

Work of the Massachusetts Highway Commission in 1909. Information from the last report on road construction and maintenance. 3000 w. Eng Rec—Feb. 5, 1910. No. 11479.

Sewage Disposal.

The Hampton Doctrine in Relation to Sewage Purification. K. Imhoff. Reply to an article by W. Owen Travis. A technical discussion of the Emscher tanks and their relation to other systems. Ills. 4500 w. Surveyor—Feb. 4, 1910. No. 11604 A.

Purification of Sewage for Power Plant Purposes. Describes the system used at works of the Allis-Chalmers Co., when the limited supply of water made it necessary to utilize the effluents for condensing water. Ills. 1200 w. Eng Rec—Feb. 19, 1910. No. 11682.

Modern Methods of Sewage Disposal. T. Aird Murray. An illustrated address giving deductions from present knowledge. 3500 w. Ap Sci—Jan., 1910. No. 11824 C.

Sewage Disposal Works, Grand Canyon, Arizona. Illustrates and describes a plant serving two hotels located where there is no adequate source of water supply, so the effluent is used as boiler water. 1200 w. Eng Rec—Jan. 29, 1910. No. 11319.

The Greater Pittsburg Sewerage and Sewage Purification Orders. Abstracts of three orders or permits issued to the city of Pittsburg, with editorial discussion. 6500 w. Eng News—Feb. 10, 1910. No. 11522.

The Sewerage Problem of Greater Pittsburgh. Explains the general conditions governing the sewerage and drainage of the city as outlined in a recent decree of the Commissioner of Health. 3500 w. Eng Rec—Feb. 12, 1910. No. 11585.

See also Columbus, O., under WATER SUPPLY.

Sewage Filters.

The Design of Small Intermittent Sewage Filters. Suggestions from a paper by Paul Hansen, before the Ohio Engng. Soc., regarding the design of small plants. 2500 w. Eng Rec—Feb. 19, 1910. No. 11687.

Sewers.

Brooklyn's Bureau of Sewers. Illustrated article describing the laboratory for testing sewer pipe, and methods used; explaining the percentage system of bidding, etc. 5500 w. Munic Jour & Engr—Feb. 2, 1910. No. 11423.

Difficult Construction of Concrete Sewer. Maury Nicholson. Illustrates and describes work at Birmingham, Ala., explaining conditions. 1500 w. Munic Jour & Engr—Feb. 9, 1910. No. 11501.

Concrete Sewers at Richmond, Ind. Frederic R. Charles. Abstract of a paper before the Ind. Engng. Soc. Recent work is described, of monolithic construction. 1200 w. Eng News—Feb. 3, 1910. No. 11409.

Sewer Construction in Baltimore. A Thousand Miles of Sewers. An illustrated account of the extensive system now under construction, and its features of special interest. 4500 w. Munic Jour & Engr—Feb. 2, 1910. No. 11422.

See also Floods, under Water Supply.

Sidewalks.

Methods and Costs of Sidewalk Construction in Chicago. Condensed from a paper by N. E. Murray, read before the Ill. Soc. of Engrs. & Surv. Deals with cinder and cement walks. 2200 w. Engng-Con—Feb. 2, 1910. No. 11427.

Street Cleaning.

See Refuse Disposal, under Municipal.

WATER SUPPLY.

Aqueducts.

Design of and Method of Constructing a Reinforced Concrete Aqueduct Lining, with Some Data on Costs. Describes construction details on aqueducts of the Illinois and Mississippi Canal. 2500 w. Engng-Con—Feb. 2, 1910. No. 11425.

Artesian.

Comments on Artesian Wells. F. J. Warden-Stevens. Deals with mechanical details relating to water supply from artesian wells. 1200 w. Archt, Lond—Jan. 21, 1910. No. 11360 A.

Columbus, O.

The Improved Water and Sewage Works of Columbus, Ohio. John H. Gregory. Illustrated detailed description of two important sanitary improvements recently completed, including works for improving the water supply, and for purifying the dry-weather flow of sewage. 31500 w. Pro Am Soc of Civ Engrs—Jan., 1910. No. 11955 E.

Conduits.

See Dams, under Water Supply.

Dams.

The Maiden Creek Filters, Dam and Conduit at Reading, Pa. Illustrated description of a concrete dam, a 60-in. circular reinforced concrete conduit, and 10 slow-sand beds. 2000 w. Eng Rec—Feb. 5, 1910. No. 11483.

Construction of Reinforced-Concrete Dam at Fredericksburg. Illustrates and describes a dam consisting of an inclined deck supported by buttresses. 1500 w. Eng Rec—Feb. 12, 1910. No. 11580.

Some Notes in Connection with the Construction of a Concrete Dam on the Trent Canal. J. B. Brophy. Illustrates and describes methods used in constructing an important work. 1200 w. Can Engr—Feb. 18, 1910. No. 11804.

Storage Curves (Staukurve). Leo Bloudek. Discusses mathematically the method of determining the curve of the surface of water stored by a dam. Ills. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 22, 1910. No. 11902 D.

Edmonton.

Pigeon Lake Gravity Water Supply. H. L. Seymour. Describes the conditions and engineering details of the gravity supply for Edmonton, Alberta, Canada. 2000 w. Can Engr—Feb. 4, 1910. No. 11485.

Filtration.

See Dams, under Water Supply.

Fire Protection.

See Fireproof, under Construction.

Irrigation.

Field Location of Canals for Irrigation. L. R. Balch. Brief outline of methods. Ills. 1200 w. Wis Engr—Feb., 1910. No. 12009 D.

See also Pumping Plants, under MECHANICAL ENGINEERING, Hydraulic Machinery.

New York City.

Waste in New York's Water Supply. Joseph Wood, Jr. Remarks on the danger of water shortage, the enormous waste, and its causes, and means of checking the loss. Ills. 3000 w. Yale Sci M—Feb., 1910. No. 11954 C.

Pipe Design.

The Calculation of Large Pipes (Beitrag zur Berechnung weiter Rohre). Otto Fröhlich. Discusses the design of pipes for several special types of loading. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 21, 1910. No. 11796 D.

Pipe Lines.

The Steel Pipe Lines and River Crossing, Little River Water Supply, Springfield, Mass. Illustrates and describes work in connection with the new water supply. 3300 w. Eng Rec—Feb. 19, 1910. No. 11686.

Pollution.

The Character of Stream Pollution as Affecting Purification Plant Design. H. E. Jordan. Read before the Indiana Engng. Soc. Describes water purification plants that have had to solve different problems. 2500 w. Munic Engng—Feb., 1910. No. 11997 C.

Purification.

The Treatment of Water Antecedent to Filtration. Walter Clemence. Considers the action of a sand filter and discusses reasons which render necessary some previous treatment of the water, describing the various processes of treating river water. Ills. 5000 w. Engng—Jan. 28, 1910. Serial. 1st part. No. 11540 A.

Water Purification for Ice and Refrigeration Plants. J. C. William Greth. Read before the Am. Soc. of Refrig. Engrs. Gives results of experimental research and useful tables and details. 6000 w. Ice & Refrig—Feb., 1910. No. 11444 C.

The New Coagulating Works of the St. Louis Water Department. Illustrated detailed description of the plant employed for adding sulphate of iron and lime to the Mississippi River water. 5000 w. Eng Rec—Feb. 12, 1910. No. 11584.

The Ultra-Violet Rays and Their Application to the Sterilization of Liquids (Les Rayons ultra-violets et leur Application à la Sterilisation des Liquides). Th. Nogier. The first part introduces a general discussion of the properties of the ultra-violet rays. Ills. Serial. 1st part. 1700 w. Tech Mod—Jan., 1910. No. 11718 D.

See also Pollution, under WATER SUPPLY.

Tunnels.

The Design of Pressure Tunnels of the Catskill Aqueduct. Notes from a paper by Thomas H. Wiggin, describing the deep, concrete lined tunnels which are to be subjected to hydrostatic pressure. 3500 w. Eng Rec—Jan. 29, 1910. Serial. 1st part. No. 11318.

Method of Making Watertight by Grouting the Yonkers Pressure Tunnel (Siphon) of the Catskill Aqueduct. Illustrated descriptive outline of the scheme for rendering the tunnel lining impervious to water. 1500 w. Engng-Con—Feb. 9, 1910. No. 11510.

Water Towers.

See Concrete Blocks, under CONSTRUCTION.

Weirs.

The Rolling Weir at Poppenweiler on the Neckar and Rolling Weirs in General (Das Walzenwehr im Neckar bei Poppenweiler und die Walzenwehre in Allgemeinen). Illustrated description. Serial. 1st part. 1800 w. Deutsche Bau—Jan. 29, 1910. No. 11775 B.

WATERWAYS AND HARBORS.

Canals.

Royal Commission on Canals and Waterways. Digest of the portion of the report referring to England and Scotland of interest to the coal trade. 2500 w. Col Guard—Jan. 21, 1910. Serial. 1st part. No. 11534 A.

Canal Improvement as Affecting Municipalities. H. C. H. Shenton. Discusses the proposals of the Royal Commission on Canals. 1600 w. Surveyor—Jan. 28, 1910. No. 11530 A.

The Danube-Save Canal and the Waterway to the Adriatic (Daten zur Frage des Danau-Save-Kanals und der zum Adriatischen Meere führenden Wasserstrasse). A technical outline of the project. Ills. 5500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 1, 1910. No. 11798 D.

Dry Docks.

See Dock Machinery, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Floods.

The Influence of Forests on Climate and on Floods. Willis L. Moore. Gives facts and figures based on careful study and presents conclusions. Maps. 16000 w. U S Com on Agri—1910. No. 11699 N.

The Great Paris Flood. Many illustrations, with remarks taken from the *N. Y. Sun.* 500 w. Sci Am Sup—Feb. 26, 1910. No. 11884.

The Floods in the Seine. Editorial and map showing the destruction caused at Paris and its outskirts. 3500 w. Engng—Feb. 4, 1910. No. 11616 A.

Paris and Its Tunnels. Illustrated description of the tunnels in Paris which have been affected by the recent inundation. 2500 w. Sci Am Sup—Feb. 5, 1910. No. 11407.

The Water Supply. Sewerage and Subways of Paris in Relation to the Present Floods. George A. Soper. Considers the hydrology of the Seine, the subterranean structures, the population and city plan, the dual water-supply, sewers, sewage farms, subways and underground railways, and the danger of epidemic. Ills. 6000 w. Eng News—Feb. 3, 1910. No. 11414.

Havre.

The Port of Havre (Le Port de Havre). A. Guiffart. The first part discusses generally the condition of the port and projected improvements. Ills. Serial. 1st part. 6500 w. Génie Civil—Jan. 15, 1910. No. 11735 D.

Inland Navigation.

Railways and Navigable Waterways (Les Chemins de Fer et les Voies Navigables). Abstracts of papers in the Bul. Int. Ry. Congress for Nov., 1909, dealing with the relation between railways and waterways in Europe. Ills. 6500 w. Génie Civil—Jan. 8, 1910. No. 11733 D.

Marine Borers.

See Timber, under MATERIALS OF CONSTRUCTION.

Panama Canal.

The Panama Canal. George W. Goethals. Read before the Engng. Soc. of the British Assn. at Winnipeg. An illustrated general description of the engineering and constructional features. 5000 w. Engng—Feb. 11, 1910. Serial. 1st part. No. 11854 A.

More Data as to the Water Supply for the Panama Canal and the Seepage from Gatun Lake. Information from the discussions of this subject by Col. H. F. Hodges, and C. M. Seville, giving authoritative data relative to the future water-supply. Maps. 5000 w. Eng News—Feb. 24, 1910. No. 11875.

Piers.

The Sewells Point Coal Pier, Virginian Railway. Illustrated description of a terminal for handling annually 4,500,000 tons of coal. 2500 w. Eng Rec—Feb 5, 1910. No. 11480.

The Reconstruction of the Tyne North Pier. Illustrated detailed description of this work. Plates. 5500 w. Engng—Jan. 28, 1910. No. 11536 A.

The Reconstruction of the Tyne North Pier. Illustrated detailed description of this interesting piece of engineering carried out at a cost of about £450,000. Plate. 4500 w. Engr, Lond—Jan. 28, 1910. No. 11542 A.

River Regulation.

River Regulation (Die Flussregulierung mittels Fangwerken). Max Jesovits. Describes a new system of construction of levees to prevent silting of channels recently tried in Austria. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 29, 1910. No. 11903 D.

San Francisco.

The Harbor of San Francisco. Illustrated detailed description of the harbor on the Pacific coast. 4500 w. Marine Rev—Feb., 1910. No. 11567.

Sea Walls.

Some Types of Sea Walls and Their Structural Characteristics and Cost. George A. Orrock. Read before the Conn. Soc. of Engrs. Illustrates and describes constructions which have been used with success, stating some of the difficulties, and approximate costs. 1500 w. Engng-Con—Feb. 16, 1910. No. 11661.

Switzerland.

The Restoration of Inland Navigation in Switzerland (Herstellung von Schiffahrtsstrassen in der Schweiz). Viktor Pirner. A review of recent developments. Ills. 3000 w. Oest Wochenschr f d Oeffentlich Baudienst—Jan. 8, 1910. No. 11900 D.

U. S. Waterways.

Preliminary Report of the United States National Waterways Commission. Full report given as an answer to the question, "Will waterways pay?" 15500 w. Eng News—Feb. 3, 1910. No. 11413.

The Improvement of American Waterways and Harbors. Gives the recommendations of the United States National Waterways Commission. 10000 w. Eng Rec—Feb. 12, 1910. No. 11587.

Some Practical Views as to Transportation on Western Rivers. Thomas P. Roberts. Discusses the reasons for the decline in the river traffic, transportation on the Ohio, cost, etc. Ills. 4000 w. Eng News—Feb. 17, 1910. No. 11644.

Traffic on the Ohio River. John Howe Peyton. Extracts from the author's book on "The American Transportation Problem." Also editorial. 6500 w. Eng News—Feb. 17, 1910. No. 11645.

Water Powers.

State Conservation of New York Water Powers. Information from the report of the State Water Supply Commission in regard to the projects, policy recommended, etc. 2500 w. Eng Rec—Feb. 5, 1910. No. 11481.

MISCELLANY.

Construction Camps.

Construction Camps in Great Britain. Gives recommendations from a recent report by Dr. Reginald Farrar to the Local Government Board. 2500 w. Eng Rec—Feb. 19, 1910. No. 11684.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

New Transmission Processes Employed in Wireless Telegraphy (Sur les nouveaux Procédés de Transmission employés en Télégraphic sans Fil). M. Ferrié. A review of progress in the development of methods for preventing interference of waves in the transmission of wireless messages. Ills. 8800 w. Bul Soc Int d'Elecns—Jan., 1910. No. 11705 F.

Submarine Cables.

Submarine Telephone Circuits Across San Francisco Bay. Samuel G. M'Meen. Illustrated description of the cable laid between San Francisco and Oakland to connect the automatic telephone systems. 1000 w. Elec Rev, N Y—Feb. 19, 1910. No. 11693.

Telegraphy.

Lord Kelvin and Telegraphy. Prof. J. A. Ewing. Abstract of second Kelvin lecture before the Inst. of Elec. Engrs. Reviews his work in submarine telegraphy. 5000 w. Elec Engr, Lond—Feb. 4, 1910. No. 11601 A.

The Work of Lord Kelvin in Telegraphy and Navigation. Prof. J. A. Ewing. (Abstract of second Kelvin lecture.) Deals especially with his work in telegraphy and in navigation. 3500 w. Elect'n, Lond—Jan. 21, 1910. No. 11376 A.

Telephony.

Condenser Telephones. C. Karl Ort and Josef Rieger. Trans. and abbreviated from the "E. T. Z." Illustrated description and report of tests. 1000 w. Elect'n, Lond—Jan. 21, 1910. No. 11373 A.

A Modern Automatic Telephone Apparatus. W. Lee Campbell. An illustrated description of the apparatus used and its method of operation in modern plants. 7500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11969 F.

The Automatic Electric Company's Telephone System. An explanation of the system, its scheme of connections, details of connectors and electors, etc. Ills. 5000 w. Engng—Feb. 11, 1910. Serial. 1st part. No. 11853 A.

See also Submarine Cables, and Telephotography, under COMMUNICATION.

Telephotography.

The Sémat Automatic Copier (Téléautocopiste Sémat); Loud-Speaking Telephones (Téléphones Haut-parleurs). F. Ducretet and E. Roger. Brief descriptions of the Sémat telautographic device and the Gaillard-Ducretet loud-speaking telephone. Ills. 1100 w. Soc Belge d'Elecns—Jan., 1910. No. 11701 E.

Time Signals.

See Electric Clocks, under MISCELLANY.

DISTRIBUTION.

Wiring.

Wiring Formulae. R. W. Krass. Gives formulae found convenient in determining the size of copper conductors, volts loss in lines, current per wire, and weight of copper per circuit for any system of electrical distribution. 800 w. Sib Jour of Engng—Feb., 1910. No. 12003 C.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Oerlikon Turbo-Generators and Alternators. A. P. Chalkley. Illustration and description. 1500 w. Elect'n, Lond—Jan. 21, 1910. No. 11375 A.

Discussion on MM. Dalémont and Herdt's Paper on the Compounding of Alternators (Discussion de la Communication de MM. Dalémont et Herdt sur le Compoundage des Alternateurs). M. Blondel. Ills. 5000 w. Bul Soc Int d Elecns—Jan., 1910. No. 11706 F.

Eddy-Current Losses in the Copper Conductors of A. C. Armatures (Ueber die Wirbelstromverluste im Leitungskupfer der Wechselstromarmaturen). F. Rusch. Mathematical. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Jan. 23, 1910. No. 11923 D.

Voltage Drop in Polyphase Synchronous Generators (Over den Spanningsafval bij meerphasige Synchronemachines). J. A. Schouten. Mathematical. Ills. 9000 w. De Ingenieur—Jan. 8, 1910. No. 11950 D.

See also Induction Generators, under DYNAMOS AND MOTORS.

A. C. Motors.

Single-Phase Commutator Motors and Their Industrial Applications (Moteurs monophasés à Collecteur et leurs Applications industrielles). Félix Roubaud. A discussion of the underlying principles of single-phase motors and of the work to which they are adapted. Ills. 3300 w. Tech Mod—Jan., 1910. No. 11714 D.

The Calculation of Leakage Losses in Three-Phase Motors (Die Berechnung der Stirnstreuung in Drehstrommotoren). Max Kloss. Mathematical. Ills. 3500 w. Elektrotech u Maschinenbau—Jan. 16, 1910. No. 11921 D.

Armatures.

Determination of the Moment of Inertia of a Continuous Current Armature. Dr. Gisbert Kapp. Read before the Inst. of Elec. Engrs. Explains the brake method and the flywheel method, and also a new electrical method, which has great advantages in the case of large machines. 2000 w. Elec Engr, Lond—Jan. 21, 1910. No. 11364 A.

Commutation.

The Present Position of the Theory of Commutation. J. Sumec. Abstract of lecture delivered before the Elektrotechnischer Verein. Shows that with straight line commutation the armature field outside the commutating zone is constant, while inside it varies slightly. Calculates the e. m. f. induced in the short-circuited coils for straight-line commutation and shows the application of formulae deduced. 2000 w. Elect'n, Lond—Feb. 11, 1910. No. 11833 A.

D. C. Generators.

The Additional Loss in D. C. Machines. J. F. H. Douglas. Abstract of a test showing the additional loss due to unequal flux-distribution under load. Ills. 1200 w. Sib Jour of Engng—Jan., 1910. No. 11964 C.

Heating.

Heating and Heat Transmission in Electrical Machines and Apparatus (Warmte en Warmteafvoer in electrische Machines en Apparaten). W. Lulofs. Mathematical. Ills. 7700 w. De Ingenieur Jan. 1, 1910. No. 11949 D.

Induction Generators.

The Induction Generator. Thomas Spooner and A. J. Barnes. A discussion of its operation in parallel with synchronous apparatus. Ills. 1000 w. Elec Wld—Feb. 24, 1910. No. 11960.

Induction Motors.

Relation Between the Stator and Rotor Circuits of the Single-Phase Induction Motor. Charles F. Smith. Aims to make clear the connection between the current and voltage in the stator of a single-phase induction motor and the current and voltage in the rotor. 5000 w. Elec Engr, Lond—Jan. 28, 1910. No. 11526 A.

The Requirements for an Induction Motor from the User's Point of View. Walter B. Nye. Discusses how to secure continuity of operation and ease of repair. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11974 F.

Synchronous Condensers.

Economics of Synchronous Condensers. B. F. Jakobsen. Discusses the monetary value of the overexcited synchronous motor in power transmission. 1700 w. Elec Wld—Feb. 10, 1910. No. 11513.

Turbo-Dynamos.

See Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

ELECTRO-CHEMISTRY.

Electrochemistry.

The Beginning of Electrochemistry. Saul Dushman. Reviews the early work of Galvani, and of Volta and the investigations following. Ills. 3500 w. Ap Sci—Feb., 1910. No. 12013 C.

Electrolysis.

The Electrolysis of Fused Metallic Materials (Schmelzflusselektrolyse). Dr. Arndt. A review of the applications of electrolysis in the extraction of refractory metals. 5500 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11941 D.

Electrometallurgy.

See Electrolysis, under ELECTRO-CHEMISTRY.

Electroplating.

Electrodeposition of Metals. Frederick Mollwo Perkin and William Earl Hughes. Read before the Faraday Soc. A short account of experiments made to ascertain the most efficient form of apparatus for the electrodeposition of metals. Describes the apparatus and its use. 1500 w. Elec Engr, Lond—Jan. 21, 1910. No. 11365 A.

The Future of Electroplating from the Electrochemists' View. Percy S. Brown. Address at meeting of Nat. Electroplaters' Assn. Remarks on the benefits of a knowledge of chemistry to the plater. 1200 w. Brass Wld—Feb., 1910. No. 11821.

Notes on Some Useful Chemical Apparatus That Can Be Employed in the Plating Room With Good Results. Illustrated descriptions. 2500 w. Brass Wld—Jan., 1910. No. 11677.

The Use of Lacquers. W. A. Jones. Address at meeting of the Nat. Electroplaters' Assn. Remarks on progress in metal work, especially in finish, color, and lacquer work. 2000 w. Brass Wld—Feb., 1910. No. 11822.

An Improved Method of Electroplating. Augustus Rosenberg. Description of the Galvanic electroplating process. Also discussion. 8500 w. Jour Soc of Arts—Feb. 4, 1910. No. 11592 A.

Modern Stereotypy, and the Mechanics of the Newspaper. Henry A. Wise Wood. Reviews the growth of the art, describing in detail how the problems encountered have evolved the modern autoplate process. Ills. 11600 w. Jour Fr Inst—Feb., 1910. No. 12016 D.

The Autoplate Machine. Report of the Franklin Institute, through its Committee on Science and the Arts, on the autoplate, a mechanism for producing stereotype plates. Ills. 2000 w. Jour Fr Inst—Feb., 1910. No. 12017 D.

Nitrates.

The Manufacture of Nitrates by the Process of the Salpetersaure-Industrie Gesellschaft (La Fabrication des Nitrates par le Procédé de la Salpetersaure-Industrie Gesellschaft). H. Marchand. Describes the Pauling system for the fixation of atmospheric nitrogen. Ills. 2200 w. L'Elecn—Jan. 8, 1909. No. 11722 D.

Turpentine.

The Electrical Distillation of Turpentine. O. Higman, Jr. Describes a process which makes economic use of waste matter at saw-mills. The invention of F. T. Snyder. Ills. 1000 w. Elec Wld—Feb. 17, 1910. No. 11642.

ELECTRO-PHYSICS.

Current Rectifiers.

Crystal Rectifiers for Electric Currents and Electric Oscillations (Iron Pyrites). G. W. Pierce. Abstract of an article in the *Phys. Rev.* Gives a curve showing the rectifying action of iron pyrites, and compares the results with those obtained with molybdenite. 1200 w. Elect'n, Lond—Feb. 11, 1910. No. 11836 A.

Electrons.

The Experimental Basis of the Electron Theory (Le Basi Sperimentali della Teoria degli Elettroni). U. Bordoni. An exhaustive presentation of the electron theory and its development. Ills. Serial. 1st part. 5300 w. Ann d Soc d Ing e d Arch Ital—Jan. 1, 1910. No. 11740 F.

Magnetic Properties.

The Magnetic and Electrical Properties of the Iron-Copper Alloys. Charles F. Burgess and James Aston. Supplementary to an earlier paper. Reports tests made of the iron-copper alloys for magnetization and electrical conductivity. 1200 w. Met & Chem Engng—Feb., 1910. No. 11420 C.

Magnetism.

Mechanical Forces on a Conductor in a Magnetic Field (Die mechanischen Kräfte auf leitende Körper in elektrischen Feld). Fritz Emde. Mathematical discussion. Ills. 4000 w. Elektrotech u Maschinenbau—Jan. 9, 1910. No. 11020 D.

Oscillations.

Vibrators and Receivers for Short Electric Waves. H.W. Webb and L. E. Woodman. Abstract from *Phys. Rev.* Describes investigations to find relations between the dimensions and properties of vibrators and receivers used in measurements with short electric waves. 2500 w. Elect'n, Lond—Feb. 4, 1910. No. 11602 A.

On the Measurement of Wave Length for High Frequency Electrical Oscillations. Albert Campbell. Abstract of a paper read before the Phys. Soc. Report of experimental investigations of wave meters. 1000 w. Elect'n, Lond—Jan. 21, 1910. No. 11377 A.

GENERATING STATIONS.

Accumulators.

The Tate Bifunctional Accumulator Plate. Illustrated description of this unit and explanation of its operation. 4000 w. Can Engr—Jan. 28, 1910. No. 11339.

The Application of Accumulators in Direct- and Alternating-Current Plants (Anwendung von Akkumulatoren in Gleichstrom- und Drehstromzentralen). Richard Werkner. A discussion of their utility in taking care of the peak load. Ills. Serial. 1st part. 3700 w. Elektrotech u Maschinenbau—Jan. 30, 1910. No. 11925 D.

Boosters.

Boosters and Their Use in Street Railway Operation. L. S. O'Dell. Considers types of boosters and systems of control. Ills. 3500 w. Ap Sci—Jan., 1910. No. 11827 C.

Central Stations.

The Problem of the Peak in Generating Stations and the Use of Thermic Accumulators (Le Problème de la Pointe dans les Usines génératrices et l'Emploi des Accumulateurs thermiques). J. Izart. A discussion of the practical value of the Halpin thermic accumulator in central-station practice. Ills. Serial. 1st part. 3000 w. L'Elecn—Jan. 8, 1910. No. 11723 D.

Generating Station of the Sayre Electric Company. Illustrates and describes an application of the exhaust steam turbine in a small plant supplying a mixed railway and lighting service. 2500 w. Elec Wld—Feb. 3, 1910. No. 11463.

Castelnuovo - Valdarno Transmission Plant. Illustrated description of an Italian generating station located at lignite mines and transmitting energy to five cities. 2000 w. Elec Wld—Feb. 10, 1910. No. 11511.

The New Berlin-Rummelsburg Power Plant. Frank Koester. Illustrated description of an interesting new installation in Europe. 1800 w. Elec Rev, N Y—Feb. 12, 1910. No. 11573.

Economics.

Industrial Engineering by the Central Station. Discusses the developing of central station power business. 8000 w. Elec Jour—Feb., 1910. No. 12000.

The Supply of Electrical Power for Industrial Establishments from Central Stations. R. S. Hale. Discusses the question of a very large station, supplying comparatively small plants. 3500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11972 F.

Ice Making and Refrigeration by Central Stations. Newton Harrison. Discusses the use of power for this service during the period of light load. 2500 w. Cent-Sta—Feb., 1910. No. 11569.

Equitable Charges for Tramway Supply. H. E. Yerbury. Discusses "fixed charges" and "running costs" and presents a scheme for the equitable apportionment of charges for energy supplied to a tramway department. 3000 w. Elect'n, Lond—Jan. 28, 1910. No. 11528.

Hydro-Electric.

Discussion on "Comments on the Development and Operation of Hydroelectric Plants." New York, December 16, 1909. Discussion of the paper of Henry L. Doherty. 37500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11968 F.

Water Requirements of Railway Hydro-Electric Plants (Die Betriebswassermenge für hydraulische Bahnkraftwerke). Artur Hruschka. Considers the effect of the type of turbine and the load-factor on the amount of water required. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1910. No. 11782 D.

Some Engineering Features of the Hakone, Japan, Hydroelectric Plant. S. Motomura. Descriptive account. 1500 w. Elec Wld—Feb. 10, 1910. No. 11512.

Engelberg-Lucerne Transmission System. Francis M. Weldon. Illustrated description of a Swiss hydroelectric generating station operating under a high head and having an unusual pole line. 2000 w. Elec Wld—Feb. 17, 1910. No. 11641.

Water-Power Plants in Sweden and Norway (Wasserkraftanlagen in Schweden und Norwegen). Illustrated description of a number of the important hydroelectric plants. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 20, 1910. No. 11784 D.

Hydro-Electric Plants of the South-West of France. (Les Installations hydroélectriques du Sud-Ouest de la France). P. Postel-Vinay. Exhaustive description of the power development and distribution systems. Ills. 11000 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11703 G.

The Plants on the Toce and Devers of the Societa per Imprese elettriche Conti (Gli Impianti del Toce e del Devers della Societa per Imprese elettriche Conti). Illustrated description. Serial. 1st part. 3000 w. Industria—Jan. 2, 1910. No. 11743 D.

The Andelsbuch Hydro-Electric Plant (Das Elektrizitätswerk Andelsbuch im Bregenzer Wald). G. Narutowicz. Detailed description of an important German water-power plant. Ills. Serial. 1st part. 2200 w. Schweiz Bau—Jan. 1, 1910. No. 11776 B.

The Mürzzuschlag Electrical Plant (Das märktische Elektrizitätswerk Mürzzuschlag). Karl Thien. Describes an important light and power plant with steam auxiliary. Ills. 3200 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11919 D.

See also Austria, under STREET AND ELECTRIC RAILWAYS.

Isolated Plants.

Electricity on an Illinois Farm. Illustrated description of a gas producer power plant with storage-battery auxiliary. 1800 w. Elec Wld—Feb. 3, 1910. No. 11465.

A Benzol Motor Lighting Plant (Eine Beleuchtungsanlage durch Benzoldynamos). Max Arbeiter. Brief description of a hotel plant in the Alps. Ills. 1500 w. Elektrotech u Maschinenbau—Jan. 23, 1910. No. 11924 D.

Rates.

Rates for Hydroelectric Service. Alton D. Adams. Discussion of the conditions determining the rates offered by ten transmission companies. 1800 w. Elec Wld—Feb. 10, 1910. No. 11514.

Signal Systems.

Power Plant Signaling System. Warren O. Rogers. Illustrated description of a signaling system between switchboard operator and engineer, consisting of whistle, illuminated signal board and order panel. 1500 w. Power—Feb. 1, 1910. No. 11340.

Switchboards.

Distant Control Switchgear. Stephen Q. Hayes. An illustrated article considering recent improvements in switchboards, apparatus, and layouts; their reliability, economy in space and time, etc. 5000 w. Elec Age—Jan., 1910. Serial. 1st part. No. 11307.

Valuation.

Electrical Undertakings and the Law of Rating. The first part discusses the rating of electric lighting and power companies. 2500 w. Elec Rev, Lond—Jan. 21, 1910. Serial. 1st part. No. 11367 A.

LIGHTING.

Arc Lamps.

Modern Arc Lamps and Their Application. A. Angold. Abstract of paper before the Assn. of Engrs-in-Charge. Considers the peculiarities of the arc stream and methods of attaining a steady arc, and describes types of arc lamps and matters related. 3000 w. Elect'n, Lond—Feb. 11, 1910. No. 11837 A.

A New Arc Lamp. P. A. Mossay. An account of a new arc lamp characterized by extreme simplicity. Ills. 2500 w. Elect'n, Lond—Feb. 11, 1910. No. 11834 A.

Incandescent Lamps.

Tests of Tungsten Lamps. T. H. Amrine and A. Guell. Describes a study of three types of tungsten lamps, differing in methods of manufacture and in scheme of mounting the filaments, with report of tests. Ills. 4000 w. Univ of Ill, Bul. No. 33—March 29, 1909. No. 11810 N.

New Incandescent Lamp Ratings. G. S. Merrill. Gives figures showing how the cost varies with the type of lamp, and the small cost of renewals. 1600 w. Cent. Sta—Feb., 1910. No. 11568.

Photometry.

The Flicker Photometer. J. S. Dow. A comparison of its performance with that of an "equality of brightness" type in color photometry. 4500 w. Elec Wld—Feb. 24, 1910. No. 11961.

The Physiological Principles Underlying the Flicker Photometer. J. S. Dow. Abstract of a paper read before the Phys. Soc. Describes experiments showing that the "Purkinje" and "yellow-spot" phenomena are less marked when using a flicker photometer. 3500 w. Elect'n, Lond—Jan. 21, 1910. No. 11372 A.

Heterochromatic Photometry. David Edgar Rice. An investigation of the subject based upon flicker photometric determinations. Ills. 2000 w. Elec Wld—Feb. 24, 1910. No. 11962.

Street.

Factors That Should Be Considered in Making Street Lighting Contracts. Discusses factors for which due allowance should be made. 1800 w. Cent Sta—Feb., 1910. No. 11570.

Queensboro Bridge Illumination. Illustrated account of the method of lighting the new cantilever across the East River at New York, and Blackwells Island, over which it passes. 2000 w. Elec Wld—Feb. 3, 1910. No. 11464.

The Proper Height for Street Lights (Die günstigste Höhe von Strassenlampen). J. Sumec. Discusses the height at which street lamps should be placed to secure most efficient illumination. Ills. 2400 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11917 D.

MEASUREMENT.

Dynamo Testing.

The Testing of Electrical Machinery. R. F. Blackmore and V. W. Newman. Abstract of paper before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the testing of small and large D. C. machines, A. C. machines, small and large induction motors, and alternators. 3000 w. Elec Rev, Lond—Jan. 21, 1910. No. 11368 A.

Tests of Turbine Alternators. Howard M. Nichols. Describes the tests to which alternating-current generators are subjected before being shipped. 3500 w. Elec Wld—Feb. 3, 1910. No. 11466.

Galvanometer Scales.

The Calculator-Board as a Calibrator of the Rymer-Jones Direct-Reading D. R. Galvanometer Scale. E. Raymond-Barker. Note for submarine cable staffs. 900 w. Elec Rev, Lond—Jan. 21, 1910. No. 11370 A.

Resistance.

The Measurement of the High-Frequency Resistance of Metallic Wires. Dr.

J. A. Fleming. Gives results of some careful measurements on the high-frequency resistance of wires. 700 w. Elect'n, Lond—Feb. 11, 1910. No. 11835 A.

Rubber Testing.

The Testing of Rubber for Electrical Work. Prof. A. Schwartz. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes a machine designed for testing rubber by hysteresis methods and discusses types of grip for holding the specimen. Ills. 3500 w. Elect'n, Lond—Jan. 21, 1910. Serial. 1st part. No. 11371 A.

The Testing of Rubber for Electrical Work. Editorial on the paper by Prof. A. Schwartz, before Inst. of Elec. Engrs., giving an account of a series of tests of tension and the determination of the hysteresis loop for various specimens under various conditions. 2000 w. Engng—Feb. 11, 1910. No. 11858 A.

Chemical and Mechanical Tests of Rubber (Prove chimiche e meccaniche del Caoutchouc lavorato). Carlo Parvopassu. A review of methods of testing rubber for electrical purposes. Ills. Serial. 1st part. 4000 w. Ann d Soc d Ing e d Arch Ital—Jan. 1, 1910. No. 11741 F.

Wave Lengths.

See Oscillations, under ELECTRO-PHYSICS.

POWER APPLICATION.

Heating.

Induction Apparatus for Converting Electrical Energy into Heat, with Special Application to the Heating of Liquids (Apparecchio ad Induzione per Convertire industrialmente in Calore l'Energia elettrica anche ad alto Potenziale, con speciale Applicazione al Riscaldamento dei Liquidi). Alfredo Ponzini. Illustrated description. 1500 w. Industria—Jan. 30, 1910. No. 11744 D.

Motor Boats.

See same title, under MARINE AND NAVAL ENGINEERING.

TRANSMISSION.

Cables.

Electric Cables. F. Fernie. The present number discusses paper-insulated lead-sheathed cables, the materials used, etc. Ills. 2500 w. Elect'n, Lond—Jan. 21, 1910. Serial. 1st part. No. 11374 A.

Direct Current.

Direct Current High Tension Transmission. A review of the direct current high tension situation showing its advantages in certain cases. Ills. 2500 w. Can Elec News—Feb., 1910. No. 11355 C.

Lightning Protection.

Lightning Conductors. Alfred Hands. Reviews the history of their use, discussing views of Sir Oliver Lodge and the report of the Lightning Research Committee. 7000 w. Elec Engr, Lond—Feb. 11, 1910. Serial. 1st part. No. 11830.

Line Design.

The Calculation of Transmission Lines. J. E. Dalemont. A review of various methods, with bibliography. 700 w. Can Elec News—Feb., 1910. Serial. 1st part. No. 11354 C.

Influences due to Extremely High Tensions in the Calculation of Transmission Lines (Influences dues aux très hautes Tensions dans le Calcul des Lignes). A. R. Garnier. Mathematical discussion of some of the phenomena introduced by high tensions. Ills.' 2500 w. L'Elecn—Jan. 15, 1910. No. 11724 D.

Lines.

Ontario Government Transmission System. P. W. Sothman. A description, without technical terms, of the different phases of the work. Ills. 2000 w. Can Elec News—Feb., 1910. No. 11356 C.

See also Hydro-Electric, under GENERATING STATIONS.

Losses.

Losses Off Transmission Lines Due to Brush Discharge, With Special Reference to the Case of Direct Current. E. A. Watson. Discusses previous work upon the subject of the corona, describing experiments upon the loss from wires under direct-current pressures. Ills. 6500 w. Inst of Elec Engrs—Feb. 10, 1910. No. 11832 N.

Polycyclic Currents.

Electrical Transmission by Polycyclic Currents. Charles F. Smith. Gives an explanation of the methods proposed for effecting an economy in transmission by the use of polycyclic currents. 3500 w. Mech Engr—Feb. 4, 1910. Serial. 1st part. No. 11607 A.

Regulations.

Legislation on the Distribution of Electrical Energy (Législation sur les Distributions d'Energie électrique). A general discussion of the economic aspects of electric-power supply in Belgium. 6500 w. Soc Belge d'Elecns—Jan., 1910. No. 11700 E.

Substations.

New Substations in Chicago. Illustrated account of isolated and combination stations of the Commonwealth Edison Co. 2000 w. Elec Wld—Feb. 24, 1910. No. 11897.

Transformers.

The Design of Constant-Potential Transformers. W. T. Ryan. The present number gives an illustrated review of the development of the transformer. 1500 w. Elec Rev, N Y—Feb. 5, 1910. Serial. 1st part. No. 11472.

Current Transformers. P. C. Morganthaler. Paper presented at the Fort Wayne Section. Considers the application of the current transformer to, and its effect upon, electrical measuring instruments. 2200 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11967 F.

MISCELLANY.

Electric Clocks.

Electric Clocks (Notes sur l'Horlogerie électrique). Léopold Reverchon. Describes various systems for the transmission of time signals. Ills. Serial. 1st part. 1700 w. L'Elecn—Jan. 29, 1910. No. 11725 D.

Germany.

The Development and Position of the Electrical Industry of Germany (Die volkswirtschaftliche Entwicklung und Lage der deutschen elektrotechnischen Industrie). Dr. Bürner. A general review. 5800 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11948 D.

Government Specifications.

Government Specifications for Electrical Apparatus. Charles F. Scott. Discusses their relation to the standardization code of the American Institute of Electrical Engineers and to manufacturers. 5500 w. Elec Jour—Feb., 1910. No. 12001.

Magnet Steel.

Permanent Magnets and Magnet Steel. Translated from *Stahl und Eisen.* Gives results of extended experiments on the retentivity of different steels. 1500 w. Ir Trd Rev. Feb. 24, 1910. No. 11891.

Rubber Gauntlets.

The Manufacture and Testing of Rubber Gauntlets. J. Lustgarten. Concerning the manufacture and testing of special rubber gloves and gauntlets for handling live wires, etc. Ills. 2000 w. Elec Rev, Lond—Jan. 21, 1910. No. 11369 A.

INDUSTRIAL ECONOMY.

Accounting.

A Technical Criticism of Balance Sheets (Technische Kritik von Industrie-Bilanzen). C. M. Lewin. Discusses inventories, misleading balance sheets, etc. Ills. 4500 w. Elektrotech u Maschinenbau—Jan. 16, 1910. No. 11922 D.

Apprenticeship.

Apprenticeship System of the Grand Trunk. An explanation of the system that has been in successful operation for a number of years. Ills. 2000 w. Ry Mas Mech—Feb., 1910. No. 11566.

Cost Systems.

Methods of Cost Analysis as Applied to Construction Work. DeWitt V. Moore. Read before the Am. Soc. of Engng. Contractors. Discusses the subject of properly recording costs, the methods as applied to labor costs, and as applied to material and expense. 5500 w. Engng-Con —Feb. 23, 1910. No. 11873.

Determining the Cost of Production in Manufacturing (Die Herstellungskosten-Berechnung in Fabrikbetrieben). C. Redtmann. A discussion of the general principles of cost keeping. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 12, 1910. No. 11911 D.

The Treatment of Time in Wage and Cost-Keeping Systems (Die Behandlung der Zeit in der Lohn- und Selbstkostenberechnung). W. Schneeloch. Discusses various methods of keeping and accounting for time. Ills. 4000 w. Tech u Wirt —Jan., 1910. No. 11931 D.

Education.

Education for Efficiency in Railroad Service. J. Shirley Eaton. A monograph on the educational preparation of young men for efficiency in railroad service. 6000 w. U. S. Bureau of Ed—Bul., 1909, No. 10. No. 11809 N.

Recent Tendencies in Technical Education in America (Les Tendances nouvelles de l'Enseignement technique et professionel en Amérique). H. Marchand. A review and discussion of recently proposed systems. 4500 w. Rev Gen d Sci—Jan. 30, 1910. No. 11720 D.

Employers' Liability.

Employers' Liability Under the Labor Insurance Act (Ueber die Haftpflicht nach dem Gewerbe-Unfall-Versicherungsgesetze). G. Link. Discusses the German law of employers' liability. Serial. 1st part. 1500 w. Elektrotech Rundschau—Jan. 5, 1909. No. 11910 D.

Engineering Libraries.

Problems and Aims of Technical Libraries (Aufgaben und Ziele technischer Bibliotheken). H. Füchsel. Discusses the equipment and management of a satisfactory technical library. Ills. 2700 w. Tech u Wirt—Jan., 1910. No. 11930 D.

Exhibitions.

The Japan-British Exhibition. Count Hirokichi Mutsu. Information concerning the proposed display to be made by Japan at the exhibition in London in 1910. Discussion. 8500 w. Jour Soc of Arts—Jan. 21, 1910. No. 11358 A.

Indexing Systems.

The Referencing of Engineering Literature. A. L. Menzin. Suggestions for improving libraries. 2000 w. Eng Rec—Jan. 29, 1910. No. 11320.

Labor.

The Patronal System in Labor Employment in Germany (Le Placement des Ouvriers par les Patrons en Allemagne). Maurice Bellom. A description of methods of registering, placing, and employing workmen through organizations in the various industries. 3500 w. Génie Civil—Jan. 29, 1910. No. 11738 D.

Management.

Organization by Production Factors. A. Hamilton Church. This sixth article of the series discusses the nature and use of control accounts. 4500 w. Engineering Magazine—March, 1910. No. 11979 B.

Factory Organization. James Rider. Read before the Rugby Engng. Soc. Discusses some of the important considerations in factory organization. 5500 w. Elec Engr, Lond—Jan. 21, 1910. No. 11366 A.

Works Management and Shop Costs. E. C. Peck. A discussion of plant organization to obtain the highest efficiency at least cost. 3500 w. Foundry—Feb., 1910. No. 11337.

The Engineering Trades on the Pacific Coast. George W. Dickie. Reviews briefly the history of engineering progress, and the recent falling off in the mechanical engineering work, and suggests a remedy. 4000 w. Jour Assn of Engng Socs—Dec., 1909. No. 11963 C.

Natural Resources.

See Timber, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Patents.

Some Hardships of Patent Infringement. L. P. Alford. Deals with certain legal steps in protecting the rights to the invention. 2500 w. Am Mach—Vol. 33. No. 6. No. 11508.

Monopoly Patents Should Not Be Granted. H. Ward Leonard. Discusses where the present system in regard to United States patents fails, giving a few suggestions. 2000 w. Am Mach—Vol. 33. No. 7. No. 11638.

The Definition of an Invention (Die Definition des Erfindungsbegriffes). Josef Löwy. Discusses the concept of an invention. 2200 w. Zeitschr d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11792 D.

A Project for the Reform of the Patent Law (Projet de Réforme de la Loi des Brevets). André Taillefer. A discussion of unsatisfactory features of the French patent regulations. Serial. 1st part. 2500 w. Tech Mod—Jan., 1910. No. 11719 D.

Philippine Islands.

The Natural Resources of the Philippine Islands. Monroe Woolley. A detailed account of the vast resources, with illustrations. 5500 w. Cassier's Mag—Feb., 1910. No. 11666 B.

Stores Keeping.

The Handling and Storing of Factory Stock. Illustrates and describes methods used by the United Shoe Machinery Company. 1000 w. Ir Age—Feb. 24, 1910. No. 11808.

Time Keeping.

See Cost Systems, under INDUSTRIAL ECONOMY.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. This second article of a series discusses the proper operation of a piece-work system. 5000 w. Engineering Magazine—March, 1910. No. 11975 B.

Relative Cost of Municipal Work Done by Day-Labor and Contract, in Boston, Mass. Harrison P. Eddy. Read before the Am. Assn. for the Adv. of Sci. Gives interesting results of investigations to determine the comparative cost and efficiency of the two systems. 4500 w. Eng News—Jan. 27, 1910. No. 11286.

Some Notes on Handling Men on Construction Work. Notes of experience brought out in a discussion on Halbert P. Gillette's paper on "Science of Management Engineering." 3500 w. Engng-Con—Jan. 26, 1910. No. 11292.

Welfare Work.

What More Than Wages? Kenneth Falconer. A review of welfare institutions, discussing conditions and the attitude of men and employers. Ills. 3500 w. Engineering Magazine—March, 1910. No. 11977 B.

Welfare Work on the Canadian Pacific Railway. Abstract of a pamphlet describing the work. 2500 w. Am Engr & R R Jour—Feb., 1910. No. 11488 C.

MARINE AND NAVAL ENGINEERING.

Electric Power.

Electrical Transmission and Communication on Shipboard (Transmissions et Communications à Bord des Navires). Georges Dary. Discusses the various uses of electricity on shipboard, particularly in communication, and the general principles of transmission. 4400 w. L'Elecn—Jan. 1, 1909. No. 11721 D.

Ferry Steamers

The Train Ferry Steamers "Deutschland" and "Preussen" (Die Eisenbahnfährschiffe "Deutschland" und "Preussen"). W. Kaemmerer. Describes the train ferries built by the Vulcan Works, Stettin, for service between Germany and Sweden. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11932 D.

Japanese Merchant Marine.

Shipbuilding and Shipping in Japan. T. Good. Brief account of their rapid upbuilding under subsidy legislation. 2000 w. Ir Age—March 3, 1910. No. 12068.

Lifeboats.

The Lifeboat and Its Work. Sir John Cameron Lamb. An account of the work of the life-saving service, describing the development of the lifeboat. Discussion. 11500 w. Jour Soc of Arts. Feb. 18, 1910. No. 12046 A.

Model Tests.

A Consideration of Results of Tests on Ships' Models (Betractung zu Resultaten von Modell-Schleppversuchen). Jul. Ott. Gives results of tests on a model of a freight and passenger steamship. Ills. Serial. 1st part. 6500 w. Schiffbau—Jan. 12, 1910. No. 11770 D.

Motor Boats.

The 1910 National Motor Boat Show. A description of exhibits, with illustrations, and general remarks on the industry. 17000 w. Naut Gaz—Feb. 24, 1910. No. 11866.

Accumulator Boats (Akkumulatoren-Boote). R. Deetjen. Discusses their design, describes equipment, gives results of operation, etc. Ills. Serial. 1st part. 4000 w. Schiffbau—Jan. 12, 1910. No. 11771 D.

Propellers.

Two, Three, or Four Propellers? A discussion of the advantages and disadvantages of the three types, concluding that twin screws still hold the field under stated conditions. 4000 w. Engr, Lond—Feb. 4, 1910. No. 11620 A.

A Synthetic Treatment of Propeller Theory (Teoria sintetica dell' Elica propulsatrice). G. Rabbeno. Mathematical. Ills. 8500 w. Riv Marit—Jan., 1910. No. 11739 E + F.

Shipbuilding.

See Dock Machinery, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Ship Deformation.

The Elastic Deformation of Ships (Elastische Formänderung des Schiffskörpers). R. Siemann. Discusses methods of measurement and calculation and gives results of investigations on various vessels. Ills. Serial. 1st part. 4000 w. Schiffbau—Jan. 26, 1910. No. 11772 D.

Steamboats.

The Pioneer Inventors of the Steamboat. Reviews the events in the development of the steamboat, aside from Fulton's work, as an argument that the proposed "water gate" to be erected on the Hudson River, at 110th St., New York City, should commemorate a historical group and not Fulton only. 4500 w. Eng News—Feb. 24, 1910. No. 11880.

The Development of Steam Navigation on the Great Lakes. James Cooke Mills. Illustrates and describes early steamboats used on Lakes Erie and Ontario, giving 15 illustrations. 4000 w. Cassier's Mag—Feb., 1910. No. 11670 B.

Steamships.

The New Castle Liner Balmoral Castle. Illustrated description of the new 13000-ton Union-Castle mail liner, recently launched. 2000 w. Int Marine Engng—Feb., 1910. No. 11498 C.

S. S. Herman Frasch. Illustrated description of a single screw steamship of the single-deck type. 1500 w. Int Marine Engng—Feb., 1910. No. 11500 C.

New Steamers for the Nippon Yusen Kaisha. Drawings, photographs and description of four new twin-screw steamers built in Japan. 3300 w. Engng—Feb. 4, 1910. Serial. 1st part. No. 11615 A.

The New Steamship of the "Zeeland" Navigation Company (Eenige gegevens betreffende de nieuwe Stoomschepen der Stoomvaart-Maatschappij "Zeeland," Koninklijke Nederlandsche Postvaart). Th. H. de Meester. Describes the new "Prinses Juliana." Ills. 5000 w. De Ingenieur—Jan. 15, 1910. No. 11951 D.

Steam Turbines.

The Westinghouse Marine Steam Turbine. Illustrated description of a new design particularly adaptable for use in connection with the Melville-Macalpine reducing gear for marine propulsion. 2000 w. Ir Age—Feb. 17, 1910. No. 11630.

American Marine Turbines and Gearing. Illustrates and describes the Westinghouse turbine and the Melville and Macalpine speed-reduction gear. 4500 w. Engr, Lond—Feb. 18, 1910. No. 12067 A.

The Main Turbines of H. M. S. Collingwood. Illustrates these turbines of the Parsons type, and gives particulars of the vessel. 2 plates. 700 w. Engr, Lond—Feb. 11, 1910. No. 11844 A.

Turbine Propulsion—Recent Developments. R. M. Neilson. Discusses certain recent developments and proposals relating to steam turbine propulsion. 7000 w. Int Marine Engng—Feb., 1910. No. 11499 C.

Submarines.

The First Submarine Boats for Austria-Hungary. Gives details of these vessels. 1700 w. Engr, Lond—Feb. 11, 1910. No. 11845 A.

Suggested Methods of Escape Out of a Sunken Submarine. George Frederick Zimmer. Illustrates and describes appliances for the safety of submarine crews. 2000 w. Cassier's Mag—Feb., 1910. No. 11669 B.

U. S. Merchant Marine.

American Shipping: Its Past, Present, and Future from a British Point of View. T. Good. Presents a British view of American marine development. 2200 w. Cassier's Mag—Feb., 1910. No. 11673 E.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Accessories.

Parts and Accessories at the New York Shows. Illustrates and describes the frames, clutches, etc., axles and bearings, springs, driving chains, radiators, carbureters, magnetos, etc. 10500 w. Com Veh —Feb., 1910. No. 11434 C.

Agricultural Machinery.

Power Cultivation of the Soil. E. W. Hamilton. Abstract of a paper read at meeting of the Am. Soc. of Agri. Engrs. A review of methods used in traction cultivation. 3300 w. Eng News—Feb. 10, 1910. No. 11523.

Clutches.

The Clutch Problem. Albert L. Clough. Considers the requirements of a good clutch, and examines the claims of various types. 2000 w. Automobile—Feb. 16, 1910. No. 11656.

Commercial Vehicles.

The Electric Commercial Vehicle at the Close of 1909. J. H. Vail. Illustrated review of recent types of vehicles, with general remarks. 1000 w. Elec Rev, N Y—Feb. 12, 1910. No. 11574.

Commercial Vehicles at the New York Shows. Discusses the characteristic features of the machines exhibited. Ills. 7500 w. Com Veh—Feb., 1910. No. 11433 C.

Compressed-Air Transmission.

Hautier Compressed-Air Transmission for Heavy Commercial Vehicles (Transmission à Air comprimé, Système Hautier, pour Véhicules industriels, Poids lourds). L. Pierre-Guédon. Describes the mechanism and discusses its efficiency. Ills. 2000 w. Génie Civil—Jan. 15, 1909. No. 11736 D.

Construction.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Crank Cases.

Some Points in Crank Case Design. Discusses briefly some of the general principles of crank case design. Ills. 1500 w. Horseless Age—Jan. 26, 1910. No. 11332.

De Dion.

Small Cars of 1910. The De Dion four-cylinder "Ten" is described as an example of the 66 M. M. class. Ills. 1500 w. Auto Jour—Jan. 22, 1910. No. 11361 A.

Design.

Sporting Two-Seaters. Eric W. Walford. Considers points of importance in the design of such cars. Ills. 2000 w. Autocar—Feb. 5, 1910. No. 11595 A.

The "Auto." Olympia Competition. The Ten Best Novelties in the Design and Construction of Motor Chassis, as Exhibited at Olympia, November 12 to 20, 1909. Bertram C. Joy. First prize essay awarded £50. Ills. 2500 w. Auto Jour Jan. 22, 1910. No. 11362 A.

The "Auto" Olympia Competition. The Ten Best Novelties in the Design and Construction of Motor Chassis as Exhibited at Olympia, November 12 to 20, 1909. Second prize essay. (Awarded £25.) Edward Butler. 3500 w. Auto Jour—Jan. 29, 1910. No. 11525 A.

Electric Batteries.

The Care and Handling of "National" Vehicle Batteries. A. H. Ackermann. Directions for unpacking, charging, discharging, cleaning, etc. 3500 w. Cent Sta—Feb., 1910. No. 11572.

Electric Vehicles.

The Performance of the Electric Vehicle in the Recent Blizzards. Frank J. Stone. Reports their very successful operation. 2000 w. Cent Sta—Feb., 1910. No. 11571.

See also Commercial Vehicles, under AUTOMOBILES.

Garages.

Some Vermont Garages. Illustrates and describes garages at Rutland, Burlington, White River Junction and other places. 2500 w. Horseless Age—Feb. 2, 1910. No. 11457.

Gears.

Remarks Relating to Gear and Pinion Failures. George Wm. Sargent. Read before the Soc. of Auto Engrs. Presents facts noticed by the author. 1000 w. Automobile—Feb. 10, 1910. No. 11551.

Ignition.

Magnetos and Auxiliary Ignition Systems. Illustrates and describes some of the appliances now used. 2200 w. Automobile—Feb. 3, 1910. No. 11468.

Industry.

The French Automobile Industry. A review of the conditions which caused the severe crisis in the industry, with a brief history of several French companies. 2500 w. Engng—Feb. 11, 1910. No. 11852 A.

Motor Control.

Foot Throttle versus Hand Throttle. Albert L. Clough. Discusses the advantages and disadvantages of the foot throttle. 1700 w. Horseless Age—Feb. 2, 1910. No. 11456.

Motor Power.

Relation of Power to Speed. Considers various sources of power losses. 1500 w. Automobile—Feb. 17, 1910. No. 11654.

Motor Rating.

Motor Ratings Discussed. Considers

some methods of determining the power delivered by the motor. 1800 w. Automobile—Feb. 17, 1910. No. 11652.

Motors.

Concerning Sleeve-Valve Petrol Engines. Illustrates and describes details of a design by Messrs. C. E. Drummond and F. J. Bostock. 2000 w. Auto Jour—Feb. 5, 1910. No. 11594 A.

Preheating the Mixture in Gasoline Motors. Forrest R. Jones. Discusses the good and bad effects of the practice. 1800 w. Automobile—Feb. 10, 1910. No. 11550.

Motor Testing.

Dynamometer Methods Employed. Discusses methods of testing an automobile motor for power and efficiency. 1800 w. Automobile—Feb. 17, 1910. No. 11653.

Motor Torque.

Motor Torque at Low Rotating Speeds. Albert L. Clough. Discusses the attainment of low speed high torque qualities. 2500 w. Horseless Age—Jan. 26, 1910. No. 11333.

Napier.

The 15 h. p. Four-Cylinder Worm-Driven Napier. Illustrated description. 1400 w. Autocar—Feb. 5, 1910. No. 11596 A.

Panhard.

The 30 h. p. Six-Cylinder Panhard. Illustrated description. 1000 w. Autocar—Jan. 22, 1910. No. 11363 A.

Springs.

Laminated Springs for Motor Cars. Laurence H. Pomeroy. Discusses the problem of springing motor vehicles and the advantages of laminated springs. 2500 w. Autocar—Feb. 12, 1910. No. 11851 A.

Tires.

Tires, Rims, and Chains. Illustrates and describes some of the latest productions. 2000 w. Automobile—Feb. 3, 1910. No. 11467.

Traction Engines.

Special Types of Traction Engines. William Fletcher. Illustrates and describes steam traction engines for colonial service. 3000 w. Cassier's Mag—Feb., 1910. No. 11672 B.

Directions for Working Steam Road Rollers and Steam Traction Engines. Instructions from a booklet issued by an English firm relating to the preparations, management, care of engine, and precautions for safety. 4500 w. Engng Con—Feb. 16, 1910. No. 11660.

Vinot.

Small Cars of 1910. Illustrated description of the Vinot "Twelve-Sixteen," as a type of the 80 mm. class. 1200 w. Auto Jour—Jan. 20, 1910. No. 11524 A.

COMBUSTION MOTORS.

Aeronautic Motors.

Points in the Design of Aeronautic Motors. Eugen P. Batzell. States the important requirements, and discusses details. 4000 w. Horseless Age—Feb. 16, 1910. Serial. 1st part. No. 11655.

The Wolseley 60-Horse-Power Motor for Aeroplanes. Views and description of a motor of British make. 500 w. Engng—Feb. 4, 1910. No. 11618 A.

Benzol Motors.

See Isolated Plants, under ELECTRICAL ENGINEERING, Generating Stations.

Fuels.

Oil Gas for Power and Lighting. General discussion of the advantages of oil gas and brief illustrated description of a plant at Alford near Chester, England. 1700 w. Engr, Lond—Jan. 28, 1910. No. 11544 A.

Gas-Engine Governing.

The Governing of Large Two-Cycle Gas Engines (Regelungen von Zweitact-Gross-Gasmaschinen). Ernst Tuckermann. An exhaustive review of methods. Serial. 1st part. 2000 w. Elektrotech Rundschau—Jan. 19, 1910. No. 11913 D.

Gas Engines.

A New Six-Stroke for Internal Combustion Engine. M. L. King. Read before the Am. Soc. of Agri. Engrs. Describes a new internal combustion engine cycle, discussing its applications, conditions and advantages. 2500 w. Naut Gaz—Feb. 3, 1910. No. 11486.

Gas Power Plants.

Test Run of a Producer and Engine Plant. William O. Webber. Illustrated description of plant at the Soldiers' Home, Chelsea, Mass., with report of test. 500 w. Power—Feb. 8, 1910. No. 11497.

Increasing Use of Producer Gas Plants. A. S. Atkinson. Remarks on the fuels used, and the increasing applications. 2200 w. Ir Trd Rev—Feb. 3, 1910. No. 11437.

Gas Producers.

A Bituminous Power Gas Producer. E. F. Bulmahn. An illustrated article describing the classes of producers and their operation, giving results and industrial applications. General discussion. 4500 w. Pro Engrs' Soc of W Penn—Jan., 1910. No. 11966 D.

Gas Turbines.

The Present Status of the Gas Turbine (Etudie über die gegenwärtige Lage der Gasturbine). Marcel Armangaud. Reviews progress, and discusses mathematically the problem of the gas turbine. Ills. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 20, 1910. No. 11783 D.

Indicator Diagrams.

A Graphical Method of Translating the Indicator Diagram of a Combustion Motor Into the Entropy Diagram (Ein graphisches Verfahren zur Uebertragung der Indikatordiagramme von Verbrennungsmaschinen in das Entropiediagramm). V. Malcev. Mathematical demonstration. Ills. 6000 w. Zeitschr d Oest Ing u Arch Ver—Jan. 14, 1910. No. 11795 D.

Lubrication.

See Engine Lubrication, under Steam Engineering.

Oil Engines.

Oil Engines for Agricultural Purposes. Editorial on the practical advantages of the oil engine and the neglect in applying it to agricultural work. 1600 w. Engng—Jan. 21, 1910. No. 11392 A.

Four-Cylinder Oil-Engine and Starting-Engine. Illustrates and describes the principal features of a crude oil engine of new type, built for the Great Indian Peninsular Ry. Co., Ltd. 1000 w. Engng—Jan. 28, 1910. No. 11538 A.

Producer Gas.

The Utilization of Gas for Lighting, Heating and Motive Power (Procédés actuels d'Eclairage, de Chauffage et de Force motrice par le Gaz). J. F. Andouin. A general review of the applications of producer gas. Ills. Serial. 1st part. 3000 w. Rev Indus—Jan. 8, 1910. No. 11729 D.

HEATING AND COOLING.

Air Purification.

The Permanent Place of the Air Washer in Heating and Ventilating Work. From the report of the Committee on Air Washers, read at meeting of the Soc. of Heat. & Vent. Engrs. Considers types and their care and efficiency. 2000 w. Heat & Vent Mag—Feb., 1910. No. 12011.

Cooling Towers.

Cooling Towers. J. R. Bibbins's paper is discussed. 9800 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11991 F.

Refrigeration.

See Economics, under ELECTRICAL ENGINEERING, Generating Stations.

Ventilation.

The Employment of Sheet-Metal Ducts in Mechanical Ventilation (L'Impiego di Canali in Lamiera nelle Installazioni di Ventilazione meccanica). C. A. Gullino. A note on their design. Ills. 3000 w. Monit Tech—Jan. 10, 1910. No. 11742 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of Centrifugal Pumps. Franz zur Nedden. The third part of a critical discussion dealing with structural features and manufacturing considerations. Ills. 2500 w. Engineering Magazine—March, 1910. No. 11981 B.

Tests of the Second Pumping Plant of the St. Gallen Water Works (Versuche an der Zweiten Pumpen-Anlage im Wasserwerk der Stadt St. Gallen). P. Ostertag. The plant consists of a high-lift centrifugal pump belt driven by a Diesel motor. Ills. Serial. 1st part. 1000 w. Schweiz Bau—Jan. 1, 1910. No. 11777 B.

Gas Pump.

The Humphrey Gas-Pumps. Editorial discussion with the object of showing the advantage of a short, as compared with a long, play-pipe. 2500 w. Engng—Feb. 11, 1910. No. 11857 A.

Hydrodynamics.

Some First Steps in the Science of Hydraulics. Ernest W. Schoder. Discusses methods of measuring the pressure head and velocity head of flowing water. Diagrams. 2000 w. Cornell Civ Engr—Feb., 1910. No. 12005 C.

Penstocks.

Steel Penstocks. R. A. Wright. Gives a general outline of the principles governing the design of steel penstocks, describing designs taken from actual installations. 4000 w. Eng News—Feb. 10, 1910. No. 11519.

Pumping Engines.

Recent Records of High-Duty Water-Works Pumping Engines. Gives results of duty tests at Albany, N. Y., and Milwaukee, Wis. Ills. 2500 w. Eng News—Feb. 3, 1910. No. 11410.

Combined Horizontal and Vertical Pumping Engines. Illustrates and describes a recent installation for Nottingham water supply, of two sets of combined horizontal and vertical Corliss triple-expansion deep-well and high-lift surface-condensing pumping engines. Plate. 1500 w. Engr, Lond—Feb. 4, 1910. No. 11623 A.

Pumping Plants.

Pumping Stations of the Minidoka Irrigation Project. Illustrates and describes the design and equipment of the pumping stations and uses made of the current from this hydroelectric development in Idaho, already described. 3000 w. Eng Rec—Feb. 19, 1910. No. 11678.

Pumps.

Artesian Well Pump. F. C. Weber. Illustrated description of new subterranean pump patented by the writer, explaining its operation, and comparing with other pumps. 3000 w. Ice & Refrig—Feb., 1910. No. 11445 C.

Pump Valves.

Pump Valves and Valve Areas. A. F. Nagle's paper on this subject is discussed generally. 3500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11992 F.

Rams.

Theory of the Hydraulic Ram (Theorie des hydraulischen Widders). H. Lorenz. Mathematical discussion. Ills. 2600 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11939 D.

Turbine Governing.

The Governing of Hydraulic Turbines (Neuerungen auf dem Gebiete des Regulatorenbaues für Wasserturbinen). Herr Euler. Describes recent types of governors. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1910. No. 11781 D.

Turbine Plants.

Designs for Hydraulic Power Plants Subject to Reduced Head During High Water. Brief illustrated description of Clemens Herschel's "fall increaser" to compensate for loss of head, and its application. 500 w. Eng News—Feb. 24, 1910. No. 11877.

Turbines.

The Type Characteristic of Impulse Wheels and Its Use in Design. S. J. Zowski. A mathematical investigation. 3500 w. Eng News—Feb. 10, 1910. No. 11518.

The Development of the Hydraulic Reaction Turbine in America. H. Birchard Taylor. An illustrated review of the progress in design and in avoiding erosion. 4000 w. Engineering Magazine—March, 1910. No. 11978 B.

Most Powerful Turbines Designed and Built. H. Birchard Taylor. Illustrated description of four 18000-h.p. hydraulic turbines recently installed at Oroville, Cal., representing the highest development of water-wheel design. 2500 w. Am Mach—Vol. 33. No. 7. No. 11635.

The Characteristics of the Francis Turbine (Ueber die Charakteristik der Francis-Turbine). Herr Kröner. Mathematical discussion. Ills. Serial. 1st part. 2000 w. Die Turbine—Jan. 5, 1910. No. 11779 D.

Water Hammer.

Water Hammer in Conduits (Coups de Bélier dans les Conduites). R. Neeser. Results of an experimental investigation and verification of Alliévis theories. Ills. Serial. 1st part. 2700 w. Bul Tech d l Suisse Rom—Jan. 10, 1910. No. 11728 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Ball Bearings (Ueber Kugellager). August Bauschlicher. A review of the development of the ball-bearing industry, discussing materials, types, design, etc. Ills. Serial. 1st part. 3500 w. Stahl u Eisen—Jan. 26, 1910. No. 11755 D.

Blows.

What Is the Force of a Blow? S. B. Redfield. Explains method of calculating the force. 1200 w. Am Mach—Vol. 33. No. 5. No. 11419.

Crane Hooks.

The Design of Curved Machine Members Under Eccentric Load. Prof. Walter Rautenstrauch's paper is discussed. 7000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11989 F.

Drafting Machines.

The Simplon Combination Drafting-Machine. Illustrated description. 800 w. Engng—Jan. 21, 1910. No. 11389 A.

Gears.

Derivation of Bevel Gear Formulas. Ralph E. Flanders. Gives derivations of the formulae for calculating the dimensions of gearing for conditions of shaft angles and types of gears. Data sheet supplement. 1000 w. Mach, N Y—Feb., 1910. No. 11350 C.

The Melville and Macalpine Reduction Gear for Marine Steam Turbines. Ralph E. Flanders. Illustrated detailed description of the gear and its tests, with personal observations. 5000 w. Mach, N Y—Feb., 1910. No. 11344 C.

See also Steel, under Materials of Construction.

Gyroscope.

The Brennan Gyroscope. A. F. Dickinson. A simple illustrated explanation of this device. 1500 w. Cassier's Mag—Feb., 1910. No. 11667 B.

Piston Rings.

The Elasticity of Piston Rings (Elasticité des Cercles de Piston). Maurice Sainturat. Mathematical discussion of their design. Ills. 3500 w. All Indus—Jan., 1910. No. 11727 D.

Springs.

The Design of Spiral Springs for Safety Under Transverse Stress (Berechnung zylindrischer Druckfedern auf Sicherheit gegen seitliches Ausknicken). E. Hurlbrink. Mathematical discussion. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11943 D.

Stresses.

Hoop or Ring Stress. Gives a chart for the determination of centrifugal tension in rims, belts, ropes, etc., explaining its use. 600 w. Prac Engr—Jan. 28, 1910. No. 11529 A.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

See Shops, under Machine Works and Foundries.

Boring.

See Machine Tools, under Machine Works and Foundries.

Brass Founding.

Diagrams of Mixtures for the Brass Foundryman. J. F. Buchanan. Gives applications of the graphic method to foundry practice and calculations, showing the proportions in various alloys. 1500 w. Foundry—Feb., 1910. No. 11338.

Chain Making.

Making Chains by Hand and Machine. Methods used in making chains for hoists and for battleships' anchors are illustrated and described. 2000 w. Am Mach—Vol. 33. No. 8. No. 11896.

Cleaning Baths.

The Cleaning of Metal Work. S. D. Benoliel. Address before the Nat. Electroplaters' Assn. Considers cleaners generally used and their properties and limitations. 3000 w. Brass Wld—Feb., 1910. No. 11823.

Forging.

Making Heavy Chain and Anchors for Uncle Sam. Chester L. Lucas. Illustrated description of the processes and machinery used in the Charlestown Navy Yard where the chains and anchors for the United States navy are made. 2000 w. Mach, N Y—Feb., 1910. No. 11347 C.

Foundries.

A Permanent Mold Gray Iron Foundry. Illustrated description of the Tacony Iron Co.'s sandless foundry, and the use of cast-iron molds and cores in the production of soil pipe fittings. 4500 w. Foundry—Feb., 1910. No. 11334.

A Sandless Iron Foundry. Illustrated detailed description of the permanent mold gray iron foundry of the Tacony Iron Co., Philadelphia. 5000 w. Ir Trd Rev—Feb. 10, 1910. No. 11552.

Foundry Buildings.

Foundry Buildings and Their Influence on Financial Returns (Giessereihallenbauten und ihre Rentabilität für den Betrieb). R. Lots. A discussion of the design, layout, and construction of foundry buildings. Ills. Serial. 1st part. 2400 w. Giesserei-Zeit—Jan. 1, 1910. No. 11769 D.

Foundry Design.

Foundry Plant and Machinery. Joseph Horner. This first article of a series considers the foundry buildings and their arrangements. 3000 w. Engng—Jan. 21, 1910. Serial. 1st part. No. 11385 A.

Foundry Practice.

The Production of Grate Bars (Ueber die Roststabgiesserei aus früherer und neuerer Zeit unter Berücksichtigung praktischer Erfahrungen und Ergebnisse). H. Vetter. A review of past and present practice. Ills. Serial. 1st part. Giesserei-Zeit—Jan. 1, 1910. No. 11767 D.

Furnaces.

Over-Fired and Under-Fired Heat Treating Furnaces. E. F. Lake. Illustrates and describes oil-burning furnaces and their equipment and management. 2500 w. Am Mach—Vol. 33. No. 5. No. 11421.

Grinding.

The Grinding Machine in Automobile Shops. H. Darbyshire. Illustrates and describes work on the cylinder grinder, machining, etc. 3500 w. Am Mach—Vol. 33. No. 5. No. 11420.

Grinding Machines.

The Operation of Emery Wheels (Betrieb von Schmirgelscheiben). A report on the conditions affecting the safety of emery wheels. 3000 w. Zeitschr f Werkzeug—Jan. 15, 1910. No. 11787 D.

Grinding Wheels.

The Manufacture of Grinding Wheels (Die Fabrikation der künstlichen Schleifscheiben). K. Voigt. Discusses materials, their preparation, and their manufacture into grinding wheels. 4200 w. Zeitschr d Ver Deutscher Ing—Jan. 15, 1910. No. 11940 D.

Jigs.

Jigs in a Repair Shop. A. H. Lavers. Illustrates a number of simple jigs for various operations; also some simple lathe and boring mill chucks. Descriptions. 2500 w. Mach, N Y—Feb., 1910. No. 11348 C.

Machine Tools.

Machine-Tools for Grinding, Boring, and Drilling. Illustrates and describes English designs. 1000 w. Engng—Feb. 11, 1910. No. 11855 A.

The Narrow Guide in Machine Tools. Fred Horner. Illustrates and describes its application to the design of sliding bearings of various kinds to prevent cramping. 1000 w. Am Mach—Vol. 33. No. 8. No. 11895.

Tool-Holder Designs. F. P. Crosby. Shows designs for turret-lathe and automatic screw machine work. 600 w. Mach, N Y—Feb., 1910. No. 11353 C.

Applications of the Electromagnet in the Machine Shop (Elektromagnetische Spannplatten). Hubert Hermanns. Describes the application of the electromagnet in holding work during machining. Ills. Serial. 1st part. 2200 w. Zeitschr f Werkzeug—Jan. 22, 1910. No. 11788 D.

Machine Tools for Mass Production (Werkzeugmaschinen für Zwecke der Massenfabrikation). Rudolf Langner. Describes various machines built by DeFries & Cie., Düsseldorf. Ills. 3000 w. Zeit d Oest Ing u Arch Ver—Jan. 7, 1910. No. 11793 D.

Experiments on the Work of Machine Tools (Expériences sur le Travail des Machines Outils). M. Codron. A continuation of the author's experiments, the first of which were described in the *Revue de Mécanique* in 1906 and 1907. This article discusses boring with an ordinary tool with rectilinear edge. Ills. Serial. 1st part. 6500 w. Rev de Mécan—Jan., 1910. No. 11926 E + F.

Milling Cutters.

A Milling Machine Attachment for Cutting Square Corners in Cotter Holes. Illustrated description. 600 w. Prac Engr—Jan. 21, 1910. No. 11379 A.

Milling Machines.

The New Kempsmith Universal Dividing Head. Illustrated detailed description. 1200 w. Ir Age—Feb. 3, 1910. No. 11416.

Molding.

Molding Patterns in Foundry Floor. Jabez Nall. Illustrates and describes the making of castings too large or too intricate for a flask. 1500 w. Am Mach—Vol. 33. No. 6. No. 11509.

Molding Machines.

European Molding Machine Practice.

Illustrated discussion of various kinds of molding machines. 2000 w. Foundry—Feb., 1910. No. 11335.

Team Work Machine Molding. Illustrated description of special work as applied to molds for car wheel centers, in the gray iron foundry of the Standard Steel Works, Burnham, Pa. 1500 w. Foundry, Feb., 1910. No. 11336.

Recent Molding Machines (Neuere Formmaschinen). Ernst A. Schott. Detailed description of the "Berkshire" machine built by Vogel & Schemmann, Kabel, Germany. Ills. Serial. 2 parts. 3000 w. Giesserei-Zeit—Jan. 1 and 15, 1910. No. 11768 each D.

Pattern Shops.

The Modern Pattern Shop. Abstract of an address by George F. Reinhard, before the Chicago Found. Foremen. Illustrates and describes details of arrangement and equipment of some representative plants. 3500 w. Ir Age—Feb. 17, 1910. No. 11627.

The Pattern Shop of To-Day. Joseph Leon Gobeille. Read before the Pittsburgh Found. Assn. Suggests changes that make for economy. 2200 w. Ir Age—Feb. 17, 1910. No. 11628.

Screw Cutting.

Thread Rolling. J. F. Springer. Principles and methods used are illustrated and described. 2000 w. Mach, N Y—Feb., 1910. No. 11351 C.

Shop Heating.

Heating a Shop Through Its Floors. Illustrated detailed description of a novel system in the plant of the Morse Chain Co., Ithaca, N. Y. 3000 w. Am Mach, Vol. 33, No. 6. No. 11506.

Heating and Ventilating Offices in Shops and Factories. Charles L. Hubbard. Describes several methods more or less efficient acording to cost. Ills. 2500 w. Mach, N Y—Feb., 1910. No. 11345 C.

Shop Lighting.

Illumination for Industrial Plants. G. H. Stickney. Treats of artificial illumination for the actual processes of manufacture. 2500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11973 F.

Shop Practice.

Shop Kinks. From the Mt. Clare Shops of the Balitmore & Ohio. F. E. Lister. Half-tone illustrations of tools and descriptions of methods used. 8500 w. Ry Age Gaz—Feb. 4, 1910. No. 11450.

Making the Marmon Car. Illustrates and describes fixtures used in boring cylinders, facing and reaming valve seats, and drilling and boring crank cases. 1500 w. Am Mach—Vol. 33, No. 8. No. 11804.

Locating Bevel Gears of Motor Car Axles. Hugh Dolnar. Deals with the bevel pinion and bevel-gear drive describing methods and special appliances used by a Cleveland company. Ills. 2500 w. Am Mach—Vol. 33, No. 7. No. 11637.

Machining Engine Standard, Cylinder and Guides. S. Lawrence. Prize paper. Describes in detail the operations. Ills. 2200 w. Mech Wld—Feb. 11, 1910. No. 11840 A.

Machining Buick Engine Cylinders. E. F. Lake. Illustrates and describes the various operations. 1000 w. Am Mach—Vol. 33, No. 7. No. 11636.

Machining Commutators. W. Burns. Describes the operation. Ills. 2000 w. Mech Wld—Feb. 4, 1910. No. 11608 A.

Laying-Out and Aligning Operations on Machine Tools. Alfred Spangenberg. Line engravings and suggestions for special cases. 2000 w. Mach, N Y—Feb., 1910. Serial. 1st part. No. 11349 C.

Automatic Turret Machine Building. F. A. Stanley. Illustrates and describes methods and tools used in a New Haven shop. 3000 w. Am Mach—Vol. 33, No. 5. No. 11418.

Making Automatic Turret Chucks. F. A Stanley. Illustrates and describes processes and special tools used in constructing automatic machine parts. 2200 w. Am Mach, Vol. 33, No. 6. No. 11507.

Shop Equipment and Practice in the German Niles Plant, Oberschöneweide (Betriebseinrichtungen und Arbeitsverfahren bei der Deutscher Niles-Werkzeugmaschinen-Fabrik in Oberschöneweide). G. Schlesinger. Ills. Serial. 1st part. 3200 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11945 D.

Shops.

A Modern Boiler Shop. E. R. Fish. Illustrated description of the Heine Safety Boiler Company's new shop at St. Louis, Mo., and its construction. 5000 w. Jour Assn of Engng Socs—Dec., 1909. No. 11958 C.

The Broad Oaks Ironworks of Messrs. Markham & Co. Limited, Chesterfield. Illustrated detailed description. Plate. 3000 w. Col Guard—Feb. 4, 1910. No. 11610 A.

Shop Ventilation.

See Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Tool Making.

A Tool Designing System That Works Well. Diagrams and description of the system of the Thomas Motor Car Co. 600 w. Am Mach—Vol. 33, No. 7. No. 11640.

Piecework in the Tool-Room. H. Graham. Gives typical examples compiled from actual records, with general remarks. Ills. 1500 w. Prac Engr—Feb. 11, 1910. No. 11838 A.

Tools.

High Speed Steel Tools. Considers tools where the bit is held to the shank or body otherwise than by clamps. Ills. 2500 w. Ir Age—Feb. 24, 1910. No. 11867.

Tool Storage.

Tool Stores Arrangement. C. L.

Browne. Suggestions for the efficient storage and the supervision of their circulation in the works. 2000 w. Mech Wld—Feb. 4, 1910. Serial. 1st part. No. 11609 A.

Welding.

A Comparison of Welding Methods for the Repair of Castings. Translation of an article by E. Lamberton, in *Stahl und Eisen*. Discusses German and American practice. Ills. 4000 w. Met & Chem Engng—Feb., 1910. No. 11431 C.

Autogenous Welding (Die autogene Schweissung). A criticism by C. Diegel of H. Rinne's paper, and a reply by the latter. Ills. 3500 w. Stahl u Eisen—Jan. 26, 1910. No. 11756 D.

Woodworking Machinery.

A New High-Speed Lathe. Illustrated description of a novel lathe embodying new features. 1800 w. Engr, Lond—Feb. 11, 1910. No. 11848 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Ninth Report to the Alloys Research Committee: On the Properties of Some Allows of Copper, Aluminium and Manganese. (With an appendix on the Corrosion of Alloys of Copper and Aluminium when Exposed to the Sea). Dr. W. Rosenhain and F. C. A. H. Lantsberry. Ills. 3500 w. Inst of Mech Engrs—Jan. 21, 1910. No. 11535 N.

Determination of the Points of Transformation of Copper-Aluminium Alloys (Détermination des Points de Transformation des Alliages Cu-Al). Maurice Barrée. A study of the variation of electrical resistance with temperature. Ills. 5200 w. Rev de Métal—Jan., 1910. No. 11709 E + F.

Alloy Steels.

Special Steels. Leon Guillet. Translated from the French. A paper presented at the Cong. of the Int. Assn. for Test. Mat. 2500 w. Ir Trd Rev—Feb. 3, 1910. No. 11436.

Aluminium Bronze.

Aluminium Bronze and What Can Be Done With It; Its Good and Bad Qualities. Erwin S. Sperry. Discusses the difficulty in casting, and hot rolling and forging. Ills. 1800 w. Brass Wld—Jan., 1910. No. 11676.

Brass.

The Failure of Non-Ferrous Metals and Alloys. T. Vaughan Hughes. Read before the Inst. of Metals. Reports an investigation of failure in practice of nonferrous metals and alloys, with particular reference to brass loco-tubes. 2500 w. Engng—Jan. 21, 1910. No. 11394 A.

Fatigue.

An Inquiry on the "Fatigue of Metals" (Enquête sur la "Fatigue des Métaux"). A symposium of replies by eminent metallurgists to a list of questions dealing with fatigue in metals. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11715 D.

Metallography.

A Report on the Progress of Metallography from the Brussels Congress to the Beginning of 1909 (Rapport sur les Progrès de la Métallographie depuis le Congrès de Bruxelles jusqu'au Commencement de l'Année 1909). E. Heyn. Presented at the Copenhagen congress of the Int. Assn for Testing Mat. 8000 w. Rev de Métal—Jan., 1910. No. 11710 E + F.

Steel.

Steel for Gears. Abstract of a report by L. P. M. Revillon, of Paris, of elaborate tests to determine the ideal combination of chemical and physical properties. 1400 w. Ir Age—Feb. 3, 1910. No. 11417.

Effect of Twisting on Iron and Steel Bars. Reports tests which show a remarkable increase in tensile strength and elastic limit. Ills. 1000 w. Ir Trd Rev. Feb. 3, 1910. No. 11435.

Investigations of the Hardness of Tempered Steels and Particularly of the Hardness of Cemented and Tempered Steels (Expériences sur la Dureté des Aciers trempés et particulièrement sur la Dureté des Aciers cémentés et trempés). A. Portevin and H. Berjot. Gives the results of an extended research. Ills. 6500 w. Rev de Métal—Jan., 1910. No. 11711 E + F.

A Study of the Gases Liberated by the Action of Cupric Salts on Steels (Etude des Gaz dégagés par l'Action des Sels cuivriques sur les Aciers). E. Goutal. Results of a study of the occlusion of gases in steel. Ills. 4000 w. Rev de Métal—Jan., 1910. No. 11708 E + F.

Tool Steels.

Development and Use of the New High-Speed Steels. Walter Carter. Read before the Birmingham Assn. of Mech. Engrs. Aims to show that steels are now made as much in advance of the ordinary high-speed steels as those were in advance of the steels they displaced. 4000 w. Engr Lond—Feb. 11, 1910. No. 11849 A.

Wire Rope.

The Elasticity of Clean, Rusted, and Galvanized Wire (Die Elastizität blanker, verrosteter und verzinkter Seildrähte). Julius Divis. An exhaustive discussion of the strength of wire rope. Serial. 1st part. 4000 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 29, 1910. No. 11760 D.

See also same title, under MINING AND METALLURGY, Mining.

MEASUREMENT.

Calorimetry.

Calorimetry. Charles L. Hubbard. Illustrates and describes the separator and throttling calorimeters. 2000 w. Elec Rev, N Y—Jan. 29, 1910. No. 11331.

Dynamometers.

See Motor Testing, under Automobiles.

Gas Meters.

The Measurement of Gas Velocities and Volumes (Messung von Gasgeschwindigkeiten und Gasmengen). A. Dosch. Describes various types of apparatus. Ills. 4200 w. Stahl u Eisen—Jan. 19, 1910. No. 11753 D.

Gauges.

The Normal Temperature of Gauges (Die Normaltemperatur von Endmass-Normalien und Massstäben). Carl Mahr. Discusses the effect of temperature on the accuracy of instruments of precision. Ills. 2000 w. Zeitschr f Werkzeug—Jan. 15, 1910. No. 11786 D.

Hardness.

A New Sclerometer. A. L. Parsons. Illustrated description of a new instrument in which the force necessary to make a scratch is measured by a spring and not by weights. 2000 w. Am Jour of Sci—Feb., 1910. No. 11819 D.

Impact Testing.

See Testing Machines, under MEASUREMENT.

Laboratories.

The New Laboratories of the University of Toronto, for Steam, Gas and Hydraulic Work. Robert W. Angus. Illustrated detailed description of the building and the equipment. 8000 w. Ap Sci—Feb., 1910. No. 12012 C.

Pitot Tube.

Various Types of Pitot Tube (Ueber verschiedene Formen Pitotscher Röhren). H. Blasius. Mathematical discussion of various types. Ills. 4000 w. Die Turbine—Jan. 20, 1910. No. 11780 D.

Pressure Gauges.

Notes on Some Errors of Fluid Differential Gages. George Jacob Davis, Jr. Explanatory notes concerning such gages and the cause and effect of the more common errors to which they are liable. 3000 w. Eng News—Feb. 24, 1910. No. 11876.

Differential Gauge for Measuring Small Pressures. Jas. Alex. Smith. Illustrated description of an instrument of the two-fluid type. 2500 w. Aust Min Stand—Jan. 5, 1910. No. 11599 B.

Pyrometry.

Recent Progress in Industrial Pyrometry. Charles R. Darling. An account of new forms of pyrometers, pointing out their distinctive improvements. Ills. 3800 w. Engr, Lond—Feb. 11, 1910. No. 11843 A.

Several Varieties of European Pyrometers. Charles E. Foster. Discusses their application and operation in the heat treatment of steel. Ills. 3000 w. Am Mach—Vol. 33. No. 7. No. 11630.

Steam Meters.

The "Sarco" Steam Recorder. Illustrated description of an instrument for measuring and recording the flow of steam. 1500 w. Engng—Jan. 28, 1910. No. 11539 A.

Testing Machines.

The Charpy Impact Testing Machine. Illustrates and describes types, explaining the action. 1000 w. Engng—Jan. 21, 1910. No. 11390 A.

Venturi Meters.

Venturi Tests for Boiler Feed. Discussion of C. M. Allen's paper on this subject. 2000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11990 F.

Verniers.

The Vernier Scale—Its Principle and Method of Reading. Diagrams and information, with supplement. 900 w. Mach, N Y—Feb., 1910. No. 11352 C.

POWER AND TRANSMISSION.

Air Compressors.

Compressing Air by Water. George C. McFarlane. Illustrates and describes a number of systems for air compression. 2200 w. Min & Sci Pr—Feb. 19, 1910. No. 11888.

Costs of Producing Compressed Air in a Canadian Mining Camp. Richard L. Webb. Aims to show the real effiiciency of air compressors as found under ordinary working conditions. 1500 w. Can Min Jour—Feb. 15, 1910. No. 11803.

The Intake Pressure in Air Compressor Cylinders. Letters from E. A. Rix and S. B. Redfield discussing the inertia of air entering the inlet pipe of an air-compressor cylinder. 2000 w. Compressed Air—Feb., 1910. No. 12015.

Recent Air Compressors (Compresseurs nouveaux). A review of recent progress, improvements and inventions in the air-compressor field. Ills. 7000 w. Rev de Mécan—Jan., 1910. No. 11928 E + F.

Electric Driving.

The Applicability of Electrical Power to Industrial Establishments. Dugald C. Jackson. Describes the present status of electrical power in factories, pointing out changes which have arisen. 2500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11970 F.

Central Stations versus Isolated Plants for Textile Mills. Charles T. Main. Considers factors affecting the cost of power, the requirements of textile mills, advantages and disadvantages, cost, etc. 4500 w. Pro Am Inst of Elec Engrs—Feb., 1910. No. 11971 F.

Electric Drive in Foundries, Works, and Mines. Hubart A. Carter. Explains the advantages of the electric drive over other means of power transmission. 3500 w. Min and Sci Pr—Feb. 5, 1910. No. 11554.

The Powering of Boiler Shops. D. S. Downs. Discusses the most important points which determine the boiler shop equipment. 1600 w. Boiler Maker—Feb., 1910. Serial. 1st part. No. 11502.

Electrical Drive for Rolling Mills. Dr. A. S. McAllister. Discusses the adaptation of electric motors to this service, the advantages of electric drive, etc. 2000 w. Met & Chem Engng—Feb., 1910. No. 11428 C.

Lubrication.

Lubrication and Lubricants. Charles F. Mabery. Presents results of extensive tests made with the Carpenter machine for testing lubricants, referring particularly to deflocculated graphite. 6000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11987 F.

The Emulsification of Oils in Turbines, Crank Chambers, etc. Jas. E. Southcombe. Discusses the objections to emulsions in lubrication and gives an account of research work with the object of preventing objectionable emulsions. 1500 w. Elec Rev, Lond—Feb. 11, 1910. No. 11831 A.

Power Generation.

The Importance of Mechanical Power. Charles Edward Lucke. Abstract of first Hewitt lecture, delivered at Cooper Union Hall, N. Y. City. Reviews the progress made in power generation. 2500 w. Power—Feb. 15, 1910. No. 11591.

The Development of Power Systems. Charles Edward Lucke. Abstract of second Hewitt lecture at Cooper Union hall, N. Y. City. Discusses natural laws and physical processes applied in power systems. 2500 w. Power—Feb. 22, 1910. No. 11864.

Power Plants.

Power Plant Wastes. Percival Robert Moses. Gives instances of preventable wastes in power plant operation. 4000 w. Cassier's Mag—Feb., 1910. No. 11668 B.

A Recent Comparison of Turbines and Engines. Warren H. Miller. Gives tables and results of a recent comparison between high-speed simple Corliss engines, high-speed tandem compounds and steam turbines, made in connection with the selection of engines or turbines for an industrial plant. 2000 w. Eng Rec—Feb. 19, 1910. No. 11683.

Mixed Pressure Turbine and Engine Plants. H. Y. Haden. Explains the possibilities of this combination for manufacturing plants of moderate size where the load is variable and there is frequent demand for exhaust steam for heating purposes. 3500 w. Power—Feb. 1, 1910. No. 11341.

The Power Station of the Allis-Chalmers Works. Illustrated description of this Milwaukee plant showing interesting features in the combination of the power, water supply and sewage disposal systems. 4000 w. Eng Rec—Feb. 12, 1910. No. 11588.

STEAM ENGINEERING.

Boiler Design.

Boiler Explosions and Riveted Joints. James Crombie. Abstract of an address delivered before the Hamilton branch of the C. A. S. E. Considers the best form of joint and the mathematical determination of the working pressure. 1200 w. Boiler Maker—Feb., 1910. No. 11503.

Boiler Draft.

See Flue Gases, under STEAM ENGINEERING.

Boiler Explosions.

See Boiler Design, under STEAM ENGINEERING.

Boiler Feeding.

See Venturi Meters, under MEASUREMENT.

Boiler Fittings.

Safety Devices for Steam Boilers (Les Appareils de Sureté des Chaudières à Vapeur). F. Sinigaglia. Describes and discusses types of water level indicators. Ills. 3200 w. Rev de Mécan—Jan., 1910. No. 11927 E + F.

Boiler Furnaces.

A Furnace for Tanbark and Similar Fuels Description given by A. A. Cary in discussion of a paper by D. M. Myers. Illustrates the McMurray furnace. 1500 w. Power—Feb. 1, 1910. No. 11342.

Tests of Two Types of Tile-Roof Furnaces Under a Water-Tube Boiler. J. M. Snodgrass. An illustrated report of tests made for the purpose of comparing boiler performance when operating with two types of furnace roofs. 3000 w. Univ of Ill, Bul. No. 34—May 10, 1909. No. 11811 N.

Boiler Plants and their Management (Industrielle Feuerungsanlagen und ihre Behandlung). Heinrich Hempel. Discusses particularly boiler furnaces and firing. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 1, 1910. No. 11757 D.

Boiler Leakage.

An Experience with Leaky Vertical Fire-Tube Boilers. F. W. Dean's paper on the difficulties experienced with such boilers is discussed generally. Ills. 4500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11993 F.

Boiler Management.

How to Burn Coal Economically. W. R. Allen. Describes how the gases of an ordinary furnace may be consumed and burned. Ills. 1500 w. Sci Am—Feb. 5, 1910. No. 11405.

The Tax Exacted from Excess Air. Henry J. Westover. Gives results of boiler tests showing the waste from this cause and the remedy. 1500 w. Power—Feb. 1, 1910. No. 11343.

Boilers.

An Interesting Chapter of Boiler History. Illustrated description of some experimental hydraulic bursting tests conducted in 1872, '73 and '74 by the Manchester Steam Users' Assn. 2500 w. Mech Engr—Feb. 4, 1910. No. 11606 A.

The Parker Down-Flow Water-Tube Boiler. Illustrated detailed description of a type constructed in Philadelphia, Pa. 3000 w. Engng—Feb. 4, 1910. No. 11614 A.

Features of the Manning Boiler. S. F. Jeter. Illustrated description of the general construction, operative features, etc. 2500 w. Power—Feb. 15, 1910. No. 11590.

Condenser Tubes.

The Diameter of Condenser Tubes. R. M. Neilson. Discusses the subject of best tube diameters. 2800 w. Engr, Lond—Jan. 21, 1910. No. 11395 A.

Condenser Water.

See Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL.

Engine Lubrication.

Cylinder Lubrication in Steam Engines and Combustion Motors (Die Zylinderschmierung der Dampfmaschinen und Verbrennungsmotoren). L. Weiss. Details results of investigations. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11944 D.

Engines.

Lentz System of Short-Built Tandem Compound Steam Engines. Illustrated detailed description. 800 w. Engng—Jan. 21, 1910. No. 11387 A.

Paul H. Müller Tandem Compound Engine with Drop-Valve Gear (Tandem-Maschine mit Ventilsteuerung System Paul H. Müller). Describes an engine built by the Zwickauer Maschinenfabrik A.-G. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—Jan. 5, 1910. No. 11909 D.

Engine Tests.

Test of a Compound Semi-Stationary Superheated Steam Engine. Illustrated description of a 50 B. H. P. semi-stationary compound superheat steam engine, with report of test showing remarkably low fuel consumption. 3000 w. Engr, Lond—Feb. 4, 1910. No. 11619 A.

Flue Gases.

The Specific Weight of Flue Gases and Chimney Draft (Betrachtungen über das spezifische Gewicht der Rauchgase und den Schornsteinzug). Leopold Nowotny. Mathematical discussion. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 29, 1910. No. 11904 D.

Fuels.

Tan Bark as a Boiler Fuel. David Moffat Myers. Addition, by the author, to a paper published in the October Journal, with general discussion. Ills. 4500 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11988 F.

Indicators.

The Steam Indicator. Illustration and description of the indicator and the method of taking diagrams. 900 w. Ry & Loc Engng—Feb., 1910. No. 11451 C.

Steam Piping.

Notes on Piping Systems for Steam Power Plants. A. G. Christie. Directions for the laying out of pipe lines. 2200 w. Ap Sci—Feb., 1910. No. 12014 C.

Economical Velocities in Steam Piping. Perry West. Discusses factors that must be considered in computing the steam velocity in piping. 1200 w. Power—Feb. 22, 1910. No. 11863.

Economical Velocities in Steam Piping. Perry West. Gives charts showing the most economical steam velocities and the corresponding size of pipe required. 2000 w. Power—Feb. 8, 1910. No. 11496.

Different Designs of Expansion Joint. Warren O. Rogers. Illustrated descriptions of several standard types, their construction and applications. 2000 w. Power—Feb. 22, 1910. No. 11865.

Strains and Stresses in Expansion Pipes (Formänderung und Beanspruchung federnder Ausgleichröhren). A. Bantlin. A theoretical consideration of expansion bends in steam pipe lines. Ills. 3700 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11936 D.

Thermic Accumulators.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Thermodynamics.

Evaluation of the Cooling Effect of Expansion without Sensible External Work (Evaluation du Froid obtenu dans une Détente effectuée sans Travail extérieur sensible). C. Monteil. Points out the inaccuracy of the Joule-Thomson formula, and demonstrates a method of calculation based on the empirical formulæ of Van der Waals, Clausius or Sarrau. 3000 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11702 G.

Turbine Balancing.

Balancing of High-Speed Turbine Shafts. A. E. Hunt. Gives an analysis of the bending action and stresses. 1000 w. Prac Engr—Feb. 4, 1910. No. 11603 A.

Turbines.

The De Laval Steam Turbine. W. O. Beyer. Outlines briefly the development of the modern steam turbine and describes in detail the De Laval invention. Ills. 5700 w. Sib Jour of Engng—Feb., 1910. Serial. 1st part. No. 12002 C.

Elementary Theory of the Steam Turbine. William E. Snow. Illustrated explanation of impulse and reaction forces and how they are combined in modern turbines. 1500 w. Power—Feb. 22, 1910. No. 11862.

The Application of the Steam Turbine to the Driving of Textile Mills. G. B.

Storie. Read before the Manchester Assn. of Engrs. Discusses important questions relating to the installing and operating of turbine plants in mills driven by mechanical as well as electrical power. 2000 w. Mech Engr—Jan. 28, 1910. Serial. 1st part. No. 11533 A.

Steam Turbines and Turbo-Dynamos (Ueber Dampfturbinen und Turbodynamos). P. Ehrlich. A review of the progress and improvements of recent years. Ills. Serial. 1st part. 2200 w. Elektrotech u Maschinenbau—Jan. 2, 1910. No. 11918 D.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbine Tests.

Tests on a Schulz Turbine (Versuche mit einer Schulz-Turbine). M. F. Gutermuth. Describes the machine and the tests and gives the results. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1910. No. 11938 D.

Test of a 1,000 Horse Power Steam Turbine of the Sächsischen Maschinenfabrik, with Special Refernce to the Influence of the Shrouding and Blade Spacing (Untersuchung einer 1000 PS—Dampfturbine der Sächsischen Maschinenfabrik, insbesondere über den Einfluss von Bandagen und Schaufelteilung). E. Josse. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 30, 1910. No. 11785 D.

Vacuum.

Diagram Indicating the Percentage of Vacuum Corresponding to Readings of the Mercury Vacuum Motor (Tabelle zum sofortigen Ablesen des Vakuums in Prozenten am Quecksilbervakuummeter). Hans Neubauer. Ills. 1700 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 15, 1910. No. 11758 D.

TRANSPORTING AND CONVEYING.

Coal Handling.

A New Type of Self-Discharging Coaling Vessel. F. C. Coleman. Illustrated description of a new system of belt-conveyor discharge. 1200 w. Sci Am—Feb. 26, 1910. No. 11882.

See also Piers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

Coal Conveyor for Loading Ships. Illustrated description of a conveyor designed by Wilson Worsdell. 700 w. Engr, Lond—Jan. 28, 1910. No. 11545 A.

Cranes.

100-Ton Giant Crane. Illustrates and describes a giant crane recently erected at the engine works of George Clark, Limited, Sunderland. It consists of a four-sided tower fixed to foundations, and having a roller path on the top, upon which the horizontal jib revolves. 1500 w. Engr, Lond—Feb. 11, 1910. No. 11850 A.

A New Graphical Method of Determining Stresses in Crane Trusses (Ein neues graphisches Verfahren zur Bestimmung der grössten Stabkräfte im Kranparabelträger). Hermann Weidemann. Mathematical discussion of a special case. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11947 D.

Dock Machinery.

The Electrical Equipment of Smith's Docks, North Shields. Illustrated description of equipment for these dry-docks and ship-repairing works. 2000 w. Elec Engr, Lond—Feb. 4, 1910. No. 11600 A.

Elevators.

Some Recent Electric Mountain Elevators (Einige neuere elektrische Berg-Aufzüge). W. A. Müller. Illustrated description of a number of novel lifts. Serial. 1st part. 1200 w. Glasers Ann—Jan. 15, 1910. No. 11791 D.

Freight Handling.

See same title, under RAILWAY ENGINEERING, TRAFFIC.

MISCELLANY.

Aeronautics.

Aeronautics in 1909 (Le Bilan de l'Aéronautique en 1909). L. Marchis. A review of progress. Ills. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11713 D.

The Pioneer of Aerial Flight. Alexander Graham Bell. Abstract of an address delivered at the presentation of the Langley medal to the Wright brothers. Reviews briefly the work of Samuel Pierpont Langley. 1200 w. Sci Am Sup—Feb. 26, 1910. No. 11885.

An Experimental Station for Airships and Flying-Machines. Brief account of the arrangements adopted at Göttengen, by Prof. L. Prandtl. 1200 w. Engng—Feb. 4, 1910. No. 11617 A.

A Novel American Monoplane. Illustrated description of the invention of A. L. Pfitzner. 1500 w. Sci Am—Feb. 12, 1910. No. 11548.

America's First Aviation Meet at Los Angeles. Illustrated detailed account of the flights made by the American and French aviators. 2000 w. Sci Am—Jan. 29, 1910. No. 11300.

The Flow of Fluids over Plane Surfaces (Die Strömung von Flüssigkeiten über Flächen). A. Rateau. Mathematical discussion of the design of aeroplane propellers. Ills. 4000 w. Die Turbine—Jan. 5, 1910. No. 11778 D.

Air Resistance.

The Resistance of the Air According to Recent Investigations (Der Luftwiderstand auf Grund der neueren Versuche). W. Schüle. Reviews the results of recent experiments and draws conclusions.

Ills. Serial. 1st part. 4700 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11934 D.

Clocks.

The Metropolitan Tower Clock in New York City. Joseph B. Baker. Illustrated detailed description of this immense clock, its lighting, chimes, and the electrical equipment. 2000 w. Elec Rev, N Y—Feb. 19, 1910. No. 11694.

Guns.

Progress in Ordnance Construction (Die Fortschritte im Geschützbau). J. Castner. A critical review of Lieut. Dawson's paper on "The Engineering of Ordnance "before the Junior Inst. of Engrs. Ills. 2800 w. Stahl u Eisen—Jan. 19, 1910. No. 11754 D.

Mechanical Engineering.

Lines of Development in Engineering (Entwicklungslinien der Technik). Prof. Kammerer. A review of development in power production and distribution, railway traction, material handling, etc. Ills. 8500 w. Tech u Wirt—Jan., 1910. No. 11929 D.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Coal Mining Accidents in the United States and Their Prevention. J. A. Holmes. Reprint of paper presented before the Nat. Civ. Fed. of N. Y. Suggests remedies or means of lesssening accidents. 1000 w. Cassier's Mag—Feb., 1910. No. 11675 B.

Accidents in Shafts. F. H. Wynne. Summary of a report of a committee appointed by the Royal Committee on Mines to inquire into the causes and means of preventing accidents from falls of ground, underground haulage and in shafts. 7000 w. Col Guard—Feb. 4, 1910. No. 11612 A.

Alaska.

Conservation and Alaskan Coal. H. Foster Bain. Maps, coal analysis, and information in regard to these coal fields. 3000 w. Min & Sci Pr—Jan. 29, 1910. No. 11446.

See also British Columbia, under Coal and Coke.

Australia.

Coal Measure of South-East Moreton. E. O. Marks. A report chiefly of the Trias Jura system, dealing with the various formations. Maps & Ills. 12500 w. Queens Gov Min Jour—Jan., 1910. Serial. 1st part. No. 11593 B.

British Columbia.

Coking Coal Deposits of the Pacific Northwest. H. Cole Estep. Considers the supplies of Washington and British Columbia and the deposits along the southern coast of Alaska. Maps. 3000 w. Ir Trd Rev—Jan. 27, 1910. No. 11313.

Coke Ovens.

Evence Coppée Waste Heat Coke Oven Plant at Pinxton. Illustrated description of a plant near Nottingham, Eng. 2000 w. Col Guard—Feb. 11, 1910. No. 11841 A.

Concrete Coke-Oven Construction. E. A. Lee. Illustrated description of the method of construction, reinforcement, etc. 3300 w. Mines & Min—Feb., 1910. No. 11440 C.

Coking By-Products.

See Blast-Furnace Gas, under Iron and Steel.

Drying.

See same title, under Ore Dressing and Concentration.

Electric Power.

Electricity in Mines: Some Practical Considerations. Robert Nelson. Abstract of paper and discussion before the Birmingham Univ. Min. Soc. Considers the electrical equipment for haulage, pumping and lighting. 6000 w. Col Guard—Feb. 4, 1910. No. 11613 A.

Electrical Installation at Cannock Chase Colliery. Illustrated detailed description of the electrification of this colliery in South Staffordshire, England. 2500 w. Ir & Coal Trds Rev—Feb. 4, 1910. No. 11625 A.

France.

See same title, under Iron and Steel.

Hardness.

The Relative Hardness of Coal, and Its Influence on Wages. Trans. from *Glückauf.* Aims to establish a comparative relation between the hardness and cost of coal mining. 1200 w. Col Guard—Feb. 4, 1910. No. 11611 A.

Illinois.

The Longwall Mines of Illinois. W. F. Peltier. Gives plan and describes the method of operation. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11583.

India.

The Colliery Manager in India. W. H. Pickering. Read before the Nat. Assn. of Col. Mgrs. Considers their duties, the mines they manage, and the mining industry. 4500 w. Ir & Coal Trds Rev—Jan. 21, 1910. No. 11402 A.

Mine Dust.

Investigations on the Drying of Mines and the Control of Mine Dust (Untersuchungen über die Austrocknung der Grubenbaue und die Bekämpfung des Kohlenstaubes). Herr Forstmann. An exhaustive discussion of the dangers of coal dust and of various methods used for combatting them. Ills. Serial. 1st part. 7000 w. Glückauf—Jan. 15. 1910. No. 11762 D.

Mine Railway.

A European Electric Colliery Railway. J. B. Van Brussel. Illustrates and describes a line connecting a colliery with a new opening, 2¼ miles distant, enabling the seams to be worked economically. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11582.

Mining.

Mining Coal with Explosives. Considers the effect of explosives in coal mining as influenced by the positions of the holes in which they are fired. Diagrams. 2500 w. Mines & Min—Feb., 1910. No. 11442 C.

Machine Mining, with Special Reference to South Wales. Sam Mavor. Abstract of a paper read before the S. Wales Inst. of Engrs. Deals with longwall mining in which system machinery can be used to advantage. 4500 w. Ir & Coal Trds Rev—Jan. 28, 1910. Serial. 1st part. No. 11546 A.

Mining Plants.

Outside Arrangements of Modern Coal Mine. Warren R. Roberts. Discusses the conditions which govern the production of coal with reference to the design of the surface mining plant. Ills. 3000 w. Eng & Min Jour—Feb. 19, 1910. No. 11692.

An Alabama Coal Mine Power Plant. Warren O. Rogers. Illustrated description of a boiler house located on a hill side, the fuel being delivered by gravity. 1200 w. Power—Feb. 8, 1910. No. 11495.

Occluded Gases.

A Study of the Condition of Gas in Coal. Rollin T. Chamberlin. Abstract from a Bulletin of the U. S. Geological Survey. 4500 w. Min Wld—Feb. 5, 1910. No. 11493.

Pennsylvania.

A Typical River Mine in Pennsylvania. Floyd W. Parsons. Illustrates and describes a rather uncommon system of handling the coal at the Crescent mine, near California, Penn. Map. 1200 w. Eng & Min Jour—Feb. 5, 1910. No. 11476.

Siberia.

Mining in Siberia. R. M. Percy. Abstract of a paper, presented to the Nat. Assn. of Col. Mgrs., describing conditions and methods of coal mining in Siberia, and the difficulties met. Ills. 5000 w. Ir & Coal Trds Rev—Jan. 28. 1910. No. 11547 A.

COPPER.

Arizona.

Geology at Globe, Arizona. F. L. Ransome. Notes based on a recent study of this copper district. 2000 w. Min & Sci Pr—Feb. 12, 1910. No. 11633.

Low-Grade Ores.

Engineering and Economic Aspects of Low-Grade Copper Deposits. C. F. Tolman. Shows the importance of low-grade ores and calls attention to deposits in the United States of chalcocite disseminations in schists. Ills. 3000 w. Engineering Magazine—March, 1910. No. 11982 B.

Nevada.

Montgomery-Shoshone Mine. A. H. Martin. Describes this mine and its development and ore treatment. 1500 w. Min & Sci Pr—Feb. 19, 1910. No. 11890.

Russia.

See same title, under GOLD AND SILVER.

Smelters.

International Smelting & Refining Co.'s Plant. Leroy A. Palmer. Illustrated detailed description of this plant under construction in Utah. 2500 w. Min Wld—Feb. 19, 1910. No. 11801.

Smelting.

Matte Smelting at Denver. H. Foster Bain. Discusses the general condition of the industry, especially the Argo smelter, the Modern smelter, and the Golden smelter. Ills. 2500 w. Min & Sci Pr—Feb. 12, 1910. No. 11631.

GOLD AND SILVER.

Colorado.

Recent Developments on Iron Hills, Leadville. George O. Argall. Discusses the geology, history, recent developments, ore deposits, etc. Ills. 4500 w. Eng & Min Jour—Jan. 29, 1910. No. 11327.

See also Ore Deposits, under MISCELLANY.

Cyaniding.

All Slime Treatment of Ore in Cyanide Plants. H. A. Megraw. Shows that no one system is suitable for all ores. Advocates a rough separation of slimes and sands, discussing economy and efficiency. 2000 w. Eng & Min Jour—Feb. 5, 1910. No. 11474.

A Rotary Extractor for Precious Metals from Solutions. W. D'Arcy Lloyd and Ernest T. Rand. Illustrated description of the machine with report of results. 2500 w. Jour Chem, Met & Min Soc of S. Africa—Dec., 1909. No. 11598 E.

Cyanide-Plant and Practice at the Minas del Tajo, Rosario, Sinaloa, Mexico. George A. Tweedy and Roger L. Beals. Illustrated detailed description, showing the progress being made. 11600 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11985 F.

Dredging.

Gold Dredging at Parocale. An account of work on the southeast coast of the Island of Luzon, Philippine Islands. 1500 w. Min & Sci Pr—Feb. 12, 1910. No. 11634.

Rock Crushing Plant Reclaiming Dredge Lands. A. H. Martin. Illustrated account of methods of removing and utilizing the debris, and restoring the ground for cultivation. 1600 w. Min Wld—Feb. 5, 1910. No. 11491.

See also Liberia, under GOLD AND SILVER.

Idaho.

Equipment and Methods at the Hecla Mine. Roy Hutchins Allen. Describes the development of this mine in the Coeur d'Alene district by levels at 300 ft. intervals. The Ilgner electric hoisting system is used. 3000 w. Eng & Min Jour—Feb. 5, 1910. No. 11473.

India.

The Great Ooregum Indian Gold Mine. T. Lington. Gives information relating to the extent and value of one of the most important gold mines in India. 1200 w. Min Wld—Jan. 29, 1910. No. 11324.

Mexico.

The Early Mining History of Pachuca, Mexico. Morrill B. Spaulding. An illustrated historical review. 3000 w. Min Wld—Feb. 19, 1910. No. 11800.

Mines of Ajuchitlan, Queretaro, Mexico. Samuel J. Lewis. Illustrated description of the deposits, and a study of the geology. 3500 w. Min & Sci Pr—Feb. 5, 1910. No. 11553.

Sonora, Mexico, in 1909. F. J. H. Merrill. A review of the mining industry during the year in the production of copper, gold and silver. 1500 w. Min & Sci Pr—Jan. 22, 1910. No. 11326.

Nevada.

Report of Goldfield Con. Mines Co., Nevada. Jos. H. McKenzie. Report of construction, mining, ore production, transportation, treatment and costs for the past year. Ills. 3500 w. Min Wld—Jan. 29, 1910. No. 11322.

Philippines.

See Dredging, under GOLD AND SILVER.

Refining.

Gold Refining. An account of a simple modification of the Wohlwill process which appears to greatly broaden its scope and applicability. The use of a pulsating current instead of a constant direct current. 2200 w. Met & Chem Engng—Feb., 1910. No. 11430 C.

Review of 1909.

Survey's Preliminary Gold and Silver Review. Waldemar Lindgren and H. D. McCaskey. Brief reviews of the conditions of this industry in the most important states and territories. 7000 w. Min Wld—Jan. 29, 1910. No. 11323.

Russia.

Russia's Gold and Copper Production. Official statistics are examined. 2200 w. Min Jour—Jan. 22, 1910. No. 11380 A.

Siberia.

Siberian Dredging Statistics for 1908. Jerome B. Landfield. Gives a resumé of statistics gathered by the Gold & Platinum Miners' Assn. of Russia, showing conditions. 1000 w. Min & Sci Pr—Jan. 22, 1910. No. 11325.

Slag Reduction.

Slag Reduction. Brief description of a slag furnace used at Taracol, Korea. Ills. 900 w. Min & Sci Pr—Feb. 5, 1910. No. 11555.

Tibet.

Gold Mines of Tibet. Alexander Del Mar. Reviews the history of these mines as far as recorded. 2000 w. Min & Sci Pr—Feb. 12, 1910. No. 11632.

IRON AND STEEL.

Alabama.

Mineral Resources of the Birmingham District. Ernest F. Burchard. An illustrated description of the geology, topography, ore deposits, mining methods, etc. Maps. 5000 w. Mfrs' Rec—Feb. 17, 1910. No. 11626.

Blast-Furnace Gas.

The Direct Production of Ammonium Sulphate (Ein Beitrag zur Geschichte der direkten Verfahren zur Gewinnung von schwefelsaurem Ammoniak). Otto Ohnesorge. Reviews the Addie, Mond, Brunck, Otto, and other processes for extracting ammonium sulphate from blast-furnace and coke-oven gases. Ills. 2500 w. Stahl u Eisen—Jan. 19, 1910. No. 11752 D.

Blast Furnaces.

Blast Furnace No. V. of the Alexandrosky Works, South Russia. M. A. Pavloff. Illustrated description of the largest blast furnace in Russia, and of interesting details of the hoisting equipment. 800 w. Engr, Lond—Jan. 21, 1910. No. 11398 A.

Blast-Furnace Slag.

Barium in Blast Furnace Slag. R. H. Sweetser. Reports observations made while having a slag with BaO in it, suggesting experimental investigation. 600 w. Ir Age—Feb. 3, 1910. No. 11415.

The Manufacture of Portland Cement from Blast Furnace Slag. Describes the plant and methods used at the Newmains works for the production of cement. Ills. 1500 w. Engr, Lond—Jan. 21, 1910. No. 11306 A.

Dry-Air Blast.

The Daubiné and Roy Process for Drying Blast-Furnace Air by Means of Calcium Chloride (L'Emploi du Chlorure de Calcium pour la Dessiccation du Vent des Hauts Fourneaux, procédé Daubiné et Roy). Detailed description of the process. Ills. Serial. 1st part. 2400 w. Génie Civil—Jan. 15, 1910. No. 11737 D.

Electrometallurgy.

The Electrical Reduction of Iron Ore. Joseph W. Richards. Describes the work of several investigators in the development and operation of this method of manufacturing pig iron on a practical commercial scale. 2500 w. Jour Fr Inst —Feb., 1910. No. 12018 D.

A New Electric Process for Producing and Refining Steel with Composite Arc Electrodes. Frank C. Perkins. Drawings of electrodes used, and description of the process. 2200 w. Can Min Jour—Feb. 1, 1910. No. 11471.

The Phenomenon of Decantation in the Electric Furnace (Phénomène de Décantation au Four électrique). Ch. Clausel de Coussergues. A discussion of the phenomena of oxidation and purification in the electric steel furnace. 2300 w. Rev de Métal—Jan., 1910. No. 11707 E + F.

Ferro-Alloys.

Ferro-Silicon. Information from a report of an investigation of the nature, uses, and manufacture of ferro-silicon, on account of the deaths and illnesses arising among the crews and passengers on boats carrying the material. 2500 w. Engr, Lond—Feb. 11, 1910. No. 11842 A.

France.

Iron and Coal in French Lorraine (Eisenerz und Kohle in Französisch-Lothringen). Herr Krecke. Brief description of the deposits. Ills. 3500 w. Glückauf—Jan. 8, 1910. No. 11761 D.

New Jersey.

Contributions to the Mineralogy of Franklin Furnace, N. J. Charles Palache. Gives results obtained in a study, continued through several years, of the minerals of this locality. 2500 w. Am Jour of Sci—Feb., 1910. No. 11820 D.

New York.

The Iron Ores of New York State. S. Norton. Synopsis of an address before the Soc. of Engrs. of Eastern New York. Illustrated article giving a general survey of the various districts and the character of the deposits. 3500 w. Ir Age—Feb. 17, 1910. No. 11629.

Ontario.

Iron Ranges of Northern and Northwestern Ontario. Abstract of the 18th annual report of the Ontario Bureau of Mines for 1909. 3000 w. Eng & Min Jour—Feb. 12, 1910. No. 11579.

Open Hearth.

The Present Position of the Basic Open-Hearth Process. O. Petersen. Trans. from *Stahl und Eisen*. Considers the importance of the mixer, the Hoesch process, and other recent processes. 2500 w. Ir & Coal Trds Rev—Jan. 21, 1910. Serial. 1st part. No. 11401 A.

Rolling Mills.

The Design of Straightening Rolls for Tubes and Bar Iron (Die Formgebung der Schrägwalzen bei Richtmaschinen für Rohre und Rundstäbe). F. Mayer. Mathematical demonstration of method of determining the proper profile. Ills. 4000 w. Stahl u Eisen—Jan. 19, 1910. No. 11751 D.

See also Electric Hoisting, under MINING.

Steel Refining.

The Present Status of Steel-Refining Processes (Zum heutigen Stand des Herdfrischverfahrens). Otto Petersen. An exhaustive review of processes, apparatus, and plants. Ills. Serial. 1st part. 22500 w. Stahl u Eisen—Jan. 5, 1910. No. 11750 D.

United States.

Foreign Ore Deposits for Eastern Blast Furnaces. B. S. Stephenson. Reports results of attempts to find new sources of supply. 4000 w. Ir Trd Rev—Jan. 27, 1910. No. 11312.

LEAD AND ZINC.

British Columbia.

St. Eugene Mine and Mill, East Kootenay, B. C. E. Jacobs. An account of Canada's most important lead-silver mine. 3500 w. Eng & Min Jour—Feb. 19, 1910. No. 11691.

Mexico.

Lead and Zinc Mining Industry of Mexico. H. B. Pulsifer. Describes the deposits, the treatment of the ores, etc. 1400 w. Min Wld—Jan. 29, 1910. No. 11321.

Missouri.

The Missouri-Kansas Lead-Zinc Industry. H. B. Pulsifer. An illustrated account of the district and its development. 3500 w. Min Wld—Feb. 12, 1910. No. 11575.

MINOR MINERALS.

Aluminium.

The Aluminium Industry in France (L'Industrie de l'Aluminium en France). R. Pitaval. Discusses its manufacture, production and applications. Ills. 9300 w. Mem Soc Ing Civ de France—Nov., 1909. No. 11704 G.

Barite.

The Geology, Mining, and Preparation of Barite in Washington County, Missouri. A. A. Steel. A detailed description of the local geology, discussing the origin of the barite; describes the methods of mining, and preparation for the market. Map and plans. 11500 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11983 F.

Cement.

The American Cement Industry and the Cement Products Exhibition. Ernest F. Burchard. A review of the industry and a description of features of the show at

Chicago. 6000 w. Mfrs' Rec—Feb. 24, 1910. No. 11870.

Recent Progress in the Cement, Lime, Phosphate and Potash Industries (Neuere Fortschritte in der Zement-, Kalk-, Phosphat- und Kaliindustrie). C. Naske. A review of recent inventions of apparatus and processes. Ills. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11933 D.

See also Blast-Furnace Slag, under Iron and Steel.

Clay Products.

The Work of the Clay Products Section of the Technologic Branch, United States Geological Survey. A. V. Bleininger. An account of the work, especially the testing of various structural materials and of clays. Discussion. Ills. 1200 w. Pro Engrs' Soc of W Penn—Jan., 1910. No. 11965 D.

Diamonds.

Premier Diamond Mine, near Pretoria, Transvaal. E. M. Weston. Illustrated description of the largest diamond pipe in the world mined by hand. 2200 w. Eng & Min Jour—Feb. 12, 1910. No. 11581.

Graphite.

Graphite. Remarks on it's qualities, formations in which it is found, and description of methods of preparation at Chester Springs, Pa. 2800 w. Mines & Min—Feb., 1910. No. 11439 C.

Lime.

See Cement, under Minor Minerals.

Nickel.

Expansion in Ontario's Nickel-Copper Fields (Canada). Alexander Gray. Discusses the Monel metal, and the importance of its development, and matters relating to the industry in Ontario. 3500 w. Min Jour—Jan. 29, 1910. No. 11532 A.

Nitrate.

The Nitrate Deposits of Chile. R. A. F. Penrose, Jr. Considers the location of the nitrate regions, giving an outline of the history of the nitrate mining industry, describing the deposits, discussing their origin, and the industrial features. Ills. 9000 w. Jour of Geol Jan.-Feb., 1910. No. 11817 D.

Oil.

The New Russian (Maikop) Naphtha Area. E. de Hautpick. Maps and account of the oil deposits, the geology, development, etc. 1500 w. Min Jour—Feb. 5, 1910. Serial. 1st part. No. 11605 A.

Phosphate.

See Cement, under Minor Minerals.

Potash.

See Cement, under Minor Minerals.

Talc.

Talc Mines and Industry of North Carolina. Claud Hafer. Describes the deposits and their development. Ills. 1000 w. Min Wld—Feb. 12, 1910. No. 11577.

Tin.

Tin Mining and Ore Dressing in South Africa. E. M. Weston. Describes the geology of the tinfields, and the three classes of bedded deposits of tin ore, the sluicing methods and hand jigging employed. Ills. 2000 w. Eng & Min Jour—Feb. 19, 1910. Serial. 1st part. No. 11688.

Electrolytic Precipitation of Tin (Beitrag zur elektrolytischen Schnellfällung des Zinns). B. Pasztor. Gives results of an investigation of electrolytic methods of tin assaying. 2100 w. Elektrochem Zeitschr—Jan., 1910. No. 11748 D.

Progress and Innovations in Tin Metallurgy During 1908 (Fortschritte und Neuerungen in der Metallurgie des Zinns im Jahre 1908). H. Mennicke. The first part gives a review of patents and a bibliography. Serial. 1st part. 2500 w. Elektrochem Zeitschr—Jan., 1910. No. 11749 D.

MINING.

Air Compressors.

See same title, under MECHANICAL ENGINEERING, Power and Transmission.

Caving System.

Caving System in Ely District. Frank Kennedy. Plans and description of method of mining. 1200 w. Wis Engr—Feb., 1910. No. 12008 D.

Drilling.

Modern Rock Drilling. Discusses the relative advantages of piston and hammer drills, reporting tests in South Africa. Ills. 2500 w. Mines & Min—Feb., 1910. No. 11438 C.

Earth Settlement.

Injuries to Buildings Located Over Mines (Angebliche Bergschäden und ihre wirklichen Ursachen). Herr Schwidtal. Discusses proper construction. 3000 w. Glückauf—Jan. 29, 1910. No. 11766 D.

Electric Hoisting.

A Comparison of the Power Fluctuations of Electric Hoists and Reversing Rolls (Ausgleich der Kraftschwankungen von elektrisch angetriebenen Hauptschachtfördermaschinen und Reversierwalzenstrassen). F. Niethammer. Ills. 2500 w. Elek Kraft u Bahnen—Jan. 14, 1910. No. 11915 D.

Electric Power.

Electrical Safety System for Use in Mines. H. J. Fisher. Explains the system devised by the author which reduces risk of shock. Ills. 2800 w. Elec Engr, Lond—Feb. 11, 1910. No. 11829 A.

Explosives.

Practical Hints on the Use of Explosives. Matt. W. Alderson. On the safe handling of explosives, giving examples of dangerous practices. 2000 w. Min Wld—Feb. 12, 1910. No. 11576.

See also same title, under RAILWAY ENGINEERING, Traffic.

Haulage.

Endless Rope Haulage. H. G. Kay. Notes on the system of hauling as practiced on diamond mining properties, where large quantities of ground are handled in open workings. 2000 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1909. No. 11597 E.

Hoisting.

Determining the Output of a Shaft with a Cylindrical Winding Drum. A. W. Brown. Abstract of a paper read before the Manchester. Geol. Soc. Diagrams and explanation of an empirical method of determining the maximum output of a vertical shaft, using a cylindrical winder, under stated conditions. 4000 w. Ir & Coal Trds Rev—Feb. 4, 1910. No. 11624 A.

Wire Ropes in Colliery Practice. R. H. Rowland. Illustrates and describes various arrangements of pulleys and discusses the benefits conferred by lubricating both winding and hauling ropes. 2500 w. Eng & Min Jour—Jan. 29, 1910. No. 11330.

Law.

A Topical Digest of the Mexican Mining Law Recently Enacted by the Mexican Congress, and Effective Jan. 1, 1910. Shows important changes in the penal provisions, but the status of aliens is unchanged. 4500 w. Eng & Min Jour—Feb. 19, 1910. No. 11690.

Mine Cars.

A Composite Mine Car. William Archie Weldin. Illustrated description of a mine car of wood and steel, discussing the advantages and disadvantages. 3000 w. Mines & Min—Feb., 1910. No. 11441 C.

Mine Locomotives.

A New Internal Combustion Locomotive. Illustrates and describes a new English mining locomotive with oil engine, for underground haulage. 600 w. Engr, Lond—Jan. 2, 1910. No. 11400 A.

Pumping.

Water Columns for Deep Level Mines. E. J. Laschinger. Formulates expressions giving the average cost of water columns for depths up to 2000 ft. vertical, in terms of the diameter, and also the cost of h.p. lost by friction. 1200 w. Ap Sci—Jan., 1910. No. 11828 C.

Shafts.

The "Walker" System of Concrete Lining for Pit Shafts. Illustrated description of a new system of lining pit shafts with concrete blocks at Tryddyn, North Wales. Plate. 3000 w. Ir & Coal Trds Rev—Feb. 11, 1910. No. 11859 A.

Shaft Tubbing (Ueber die Verstärkung der Tübbings durch geeignete Formgebung). Herr Heise. Discusses the form of tubbing to give greatest strength in shaft lining. Ills. 2000 w. Glückauf—Jan. 22, 1910. No. 11764 D.

Shaft Sinking.

Improved Shaft-Sinking Methods at Ducktown. William Young Westervelt. Describes interesting work in Tennessee. Plan. 800 w. Eng & Min Jour—Jan. 29, 1910. No. 11329.

Stowing.

Sand Dumping Bridges for the Waste Stowing Plant of the Upper Silesia Coal Mines (Sandabsturzbrücken für den Spülversatz der oberschlesischen Kohlenbergwerke). Karl Bernhard. Describes a bridge over a waste-storage plant on which cars of sand are dumped. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1910. No. 11937 D.

Timbering.

Economics in the Use of Steel in Mine Timbering. R. B. Woodworth. Abstract of paper read before the W. Va. Coal Min. Inst. Calls attention to advantages and points out considerations necessary for its successful use. 3000 w Min Wld—Feb. 5, 1910. No. 11494.

Armored Concrete in Mines. Illustrates and describes armored concrete washery bunkers erected in South Wales and other places; and also shaft work and incline and platform work in France; viaducts, etc. 1200 w. Engr, Lond—Jan. 21, 1910. No. 11399 A.

Unwatering.

Unwatering the Mexiamora Mine at Guanajuato. F. H. Clark. An account of many attempts that failed and the final success. 1600 w. Eng & Min Jour—Jan. 29, 1910. No. 11328.

Wire Rope.

Method of Splicing Wire and Other Ropes. J. Watt. Illustrated detailed instructions for making and tapering long, short, and eye splices. 1400 w. Eng & Min Jour—Feb. 19, 1910. No. 11689.

ORE DRESSING AND CONCENTRATION.

Classification.

The Keedy Sizer for Classifying Complex Ores. Carl F. Dietz and Dyke V. Keedy. Shows the importance of sizing, and describes a machine which aims to separate accurately at low power and maintenance cost. 5000 w. Eng & Min Jour—Feb. 5, 1910. No. 11475.

Drying.

The Efficiency of Heat Dryers. W. B. Ruggles. Brief illustrated description of apparatus for drying granular materials. 700 w. Cassier's Mag—Feb., 1910. No. 11671 B.

Recent Processes and Apparatus for Coal Drying (Neuere Verfahren und Einrichtungen auf dem Gebiete der Kohletrocknung). Herr Jordan. Illustrated description of a number of devices. 4500 w. Glückauf—Jan. 15, 1910. No. 11763 D.

Gold Milling.

Recent Milling Practice. A. E. Drucker. A short description of recent important changes in Korea, Philippines, and India. 2000 w. Min & Sci Pr—Feb. 19, 1910. No. 11889.

Equipment and Practice at Florence-Goldfield Mill. H. G. Morris. Illustrates and describes the mill and its equipment, criticizing the arrangement of batteries, and other features of the practice. 1200 w. Eng & Min Jour—Feb. 12, 1910. No. 11580.

Lead Milling.

See British Columbia, under Lead and Zinc.

Tin.

See same title, under Minor Minerals.

MISCELLANY.

Brazil.

The Mineral Wealth of the State of Bahia, Brazil. A. J. de Sousa Carneiro. A report of the mineral deposits found, including diamonds, and other gems, gold, silver, copper, and many minerals of value. 2500 w. Min Jour—Feb. 12, 1910. No. 11839 A.

Igneous Rocks.

Igneous Rocks: Their Classification in the Field. Gordon Surr. Considers briefly the more important mineral bearing rocks, the texture of igneous rocks, volcanic glasses, etc. 8500 w. Min Wld—Feb. 5, 1910. No. 11492.

Japan.

Mining in Japan (Der Bergbau Japans). W. Paul. A review of the mining industry. 6500 w. Glückauf—Jan. 22, 1910. No. 11765 D.

Korea.

The Economic Ore Deposits of Korea (Die nutzbaren Lagerstätten Koreas). A brief review of Korea's mineral resources. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 22, 1910. No. 11759 D.

Nova Scotia.

Nova Scotia's Mineral Output in 1909. Arthur S. Barnstead. A review of the mining industry, production, etc. 2500 w. Can Min Jour—Feb. 1, 1910. No. 11470.

Ore Deposits.

The Genesis of the Leadville Ore-Deposits. Max Boehmer. Explains their origin as shown by recent developments. 1200 w. Bul Am Inst of Min Engrs—Feb., 1910. No. 11984 F.

Refractory Materials.

Refractories in Furnace Construction. Notes from a treatise recently issued by the Harbison-Walker Refractories Co., Pittsburgh, Pa., giving a summary of the principal refractories used, especially in open-hearth furnace bottoms. 1000 w. Met & Chem Engng—Feb., 1910. No. 11432 C.

Yukon.

Condition and Needs of Mining in the Yukon. F. T. Congdon. Extracts from a speech describing conditions in the Yukon, explaining the causes of the reduction of revenue and discussing the policy of the Canadian government. 3800 w. Can Min Jour—Feb. 1, 1910. No. 11469.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Color Blindness.

Colour-Blindness. F. W. Eldridge-Green. The author explains the theory adopted in order to explain vision and colour-vision, discussing the practical side of the subject. General discussion. 8800 w. Jour Soc of Arts—Feb. 11, 1910. No. 11860 A.

Signaling.

Drafting Room Practice in the Signal Department. Albert G. Moore. Outlining the signal drafting methods adopted by the Illinois Central. 2000 w. Ills. Sig Engr—Feb., 1910. No. 11696.

Signaling and Interlocking on the Victorian Railways. F. M. Calcutt. An illustrated résumé of standard practice. 900 w. Sig Engr—Feb., 1910. No. 11695.

The World System of Railway Signals. Illustrated description of the method of illuminating the background of this signal. 800 w. Ry & Loc Engng—Feb., 1910. No. 11450 C.

Railway Signals. Critical letter on the signal systems in use. 2000 w. Ry & Loc Engng—Feb., 1910. No. 11449 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Manipulation and Operation in General Freight Service, with a Review of Some of the Causes and Conditions Which Produce Shocks and Break-in-Twos. W. V. Turner. Ills. 16500 w. Pro W Ry Club—Dec. 21, 1909. No. 12020 C.

K. Triple Valve Tests. Gives tabulated results of tests with remarks. 800 w. Ry & Loc Engng—Feb., 1910. No. 11452 C.

Air Brake Study. Suggestions for study of air brakes. 1200 w. Ry & Loc Engng—Feb., 1910. No. 11453 C.

Car Disinfection.

The Disinfection of Passenger Cars in Shops (Die Desinfektion der Eisenbahn-Personenwagen in den Werkstätten). Herr Schumacher. Detailed description of a disinfecting plant in Potsdam. Ills.

3000 w. Glaser's Ann—Jan. 15, 1910. No. 11790 D.

Electrification.

The Electrification of Trunk Lines. L. R. Pomeroy. Discusses the commercial considerations relating to this question. 5000 w. Jour Am Soc of Mech Engrs—Feb., 1910. No. 11986 F.

The Electrification of Trunk Lines. L. R. Pomeroy. The basis of an address recently given before the Engng. Soc. of Columbia Univ., N. Y. A discussion of the problem of electrification. 5000 w. Am Engr & R R Jour—Feb., 1910. No. 11487 C.

The Electrification of Trunk Lines. L. R. Pomeroy. Abstract of an address before the Engng. Soc. of Columbia Univ. Gives a survey of the present situation, with conclusions. 4000 w. Ry Age Gaz—Feb. 18, 1910. No. 11663.

See also Track Maintenance, under STREET AND ELECTRIC RAILWAYS.

Freight Cars.

Steel Box Car for the Union Pacific. Illustrated description of a car built at the Omaha shops. 200 w. Ry Age Gaz—Feb. 11, 1910. No. 11562.

Hopper-Ballast Wagons on the Queensland Railways. Illustrates and describes the older and more recent forms of hopper-wagons used. 300 w. Engng—Jan. 28, 1910. No. 11537 A.

Locomotive Boilers.

The Locomotive Boiler from a Purely Practical Point of View. Leslie McLaren. Observations from the engineman's point of view, especially with regard to the smoke nuisance and the emission of sparks. Ills. 1500 w. Boiler Maker—Feb., 1910. No. 11505.

Locomotive Boiler Inspection. Garland P. Robinson. From the third annual report, N. Y. Pub. Service Com. 1600 w. Boiler Maker—Feb., 1910. No. 11504.

Pennsylvania Railroad Specifications for Steel Boiler Tubes and Safe Ends. Gives specifications covering cold and hot-drawn and lap-welded steel tubes and safe ends. 1200 w. Ry Age Gaz—Feb. 4, 1910. No. 11462.

Locomotive Power.

The Tractive Power of Locomotives. William N. Allman. Discusses the calculation of tractive power. 2000 w. Ry Age Gaz—Feb. 11, 1910. No. 11563.

The Tractive Power of Simple and Compound Locomotives. Sidney C. Carpenter. Gives diagrams, showing a close approximation of the tractive power without calculation, and examples illustrating their use. 500 w. Ry Age Gaz—Jan. 28, 1910. No. 11302.

Locomotives.

Simple 4-6-2 and 2-8-0 for the Chicago & North-Western. Illustrated description of a Pacific type engine, and a consolidation type. 1200 w. Ry & Loc Engng—Feb., 1910. No. 11455 C.

New Consolidation Locomotive of the Lehigh Valley R. R. Illustrated description of an interesting engine showing unusual details. 700 w. Ry & Engng Rev—Feb. 12, 1910. No. 11558.

Heavy Consolidation Locomotive. Illustrated description of heavy consolidation locomotive, class H8b for the Pennsylvania Railroad. 1500 w. Am Engr & R R Jour—Feb., 1910. No. 11490 C.

Ten-Wheel Passenger Locomotive, with Emerson Superheater, and Consolidation Locomotive. Illustrated description of engines for the Chicago, Great Western Railway. 900 w. Am Engr & R R Jour—Feb., 1910. No. 11489 C.

Baldwin 4-4-2 for the Idaho & Washington Northern. Illustrated detailed description of a simple engine using moderately superheated steam. 800 w. Ry & Loc Engng—Feb., 1910. No. 11448 C.

Notes on Great Western Express Locomotives and Their Work. Reports the work of 4-6-0 four-cylinder, non-compound locomotives. 5000 w. Engr, Lond—Feb. 11, 1910. No. 11847 A.

Eight-Wheel Engines with Superheaters for the Western Railway of Havana. Illustrated description of engines equipped with the builders' latest design of fire-tube superheater with side headers. 900 w. Ry Age Gaz—Feb. 25, 1910. No. 11953.

Mallet Compound Locomotive for the Central South African Railways. Illustrated description of an articulated compound for a narrow gage road. 900 w. Ry & Engng Rev—Feb. 19, 1910. No. 11861.

Mallet Articulated Compound Locomotive for the Colombia National. Illustrated detailed description of engines to be operated on a track of 3-ft. gage, laid with 45-lb. rails. 1200 w. Ry Age Gaz—Feb. 18, 1910. No. 11664.

New Pacific Type Express Engines for the P. L. M. Railway Company. Illustrations and dimensions of new compound and non-compound engines for this French railway. 200 w. Engr, Lond—Jan. 28, 1910. No. 11543 A.

Recent Light-Railway Locomotives (Neuerungen im Bau von Kleinbahnlokomotiven). A. Doeppner. Describes types recently produced in Europe. Ills. 4500 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens — Jan., 1910. No. 11747 F.

Garratt Compound, Truck-Drive Locomotive for the Tasmanian State Railways (Locomotive compound à Bogies moteurs et à Chaudière indépendante, système Garratt, des Chemins de Fer de l'Etat de Tasmanie). Illustrated description. 1500 w. Génie Civil—Jan. 8, 1910. No. 11732 D.

Locomotive Superheaters.

Flue Type Superheaters for Locomotives. Illustrates and describes an improved superheater, designed by G. T. Churchward. 1500 w. Prac Engr—Jan. 21, 1910. No. 11378 A.

Locomotive Tests.

Results of the Test Runs with the 4/5 Coupled Compound Freight Locomotives, Group 730, of the Italian State Railways (Ergebnisse der Versuchsfahrten mit der 4/5-gekuppelten Verbund - Güterzuglokomotive Gruppe 730 der Italienischen Staatsbahnen). G. Heise. Describes the locomotive and tests and gives detailed results. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—Jan. 22, 1910. No. 11942 D.

Motor Cars.

Motive Power of Motive Cars. Francis W. Lane. An illustrated description of what has been accomplished in steam cars and gasoline cars. 3500 w. Ry Mas Mech—Feb., 1910. No. 11565.

Shops.

New Shops of Central Georgia at Macon, Ga. Illustrated detailed description of the completed shops of a new plant under construction. 5500 w. Ry Age Gaz—Feb. 4, 1910. No. 11460.

Tool Lay-Out for the Scranton Shops of the Delaware, Lackawanna & Western. George L. Fowler. The arrangement and grouping of the tools on the floor of the shop is described and plans given. 3500 w. Ry Age Gaz—Feb. 4, 1910. No. 11461.

Finishing Locomotive Driving Wheels and Axles. Editorial on present practice on driving wheel work in repair shops. 2000 w. Ry Age Gaz—Feb. 4, 1910. No. 11458.

See also Roundhouses, under Permanent Way and Buildings.

Springs.

A Study of the Springs Employed in the Construction of Railway Cars (Etude des Ressorts employés dans les Véhicules de Chemins de Fer). P. Piérart. The first part discusses laminated springs, their design, construction, incorporation in car construction, etc. Ills. Serial. 1st part. 2000 w. Tech Mod—Jan., 1910. No. 11716 D.

Train Ferries.

See Ferry Steamers, under MARINE AND NAVAL ENGINEERING.

Wheel Contacts.

Area of Contact Between Car Wheels and Rails. E. L. Hancock. An illustrated account of experimental work to determine the area of contact. 2200 w. Eng News—Feb. 10, 1910. No. 11516.

PERMANENT WAY AND BUILDINGS.

Construction.

Some Notes on Specifications for Earthwork in Railway Construction. Notes prepared by James H. Bacon touching upon questions of classification and overhaul in an interesting manner. 1200 w. Engng-Con—Feb. 23, 1910. No. 11872.

Elevated Railways.

Track Elevation at Evanston, Ill., Chicago, Milwaukee & St. Paul Ry. E. O. Greifenhagen. Describes interesting construction work in connection with grade separation. Ills. 9500 w. Eng News—Feb. 10, 1910. No. 11517.

See also Stations, under Permanent Way and Buildings.

Grade Reduction.

Colfax Grade Revision; Southern Pacific. Bradford Boardman. Illustrated detailed account of a low-grade line under construction in California. 4500 w. Ry Age Gaz—Feb. 18, 1910. No. 11662.

Location.

Railroad Location. W. G. Swan. A detailed account of preliminary work, outfitting, methods of work, survey and final location. Ills. 5000 w. Ap Sci—Jan., 1910. No. 11826 C.

Narrow Gauge.

The Cochin Forest Railway. Edward Harran. Illustrated description of a tramway line on the meter gage in South India, for working valuable forests on scientific principles. 1200 w. Sci Am—Feb. 26, 1910. No. 11883.

Reconstruction.

Harlem River Branch Improvements, New York, New Haven & Hartford. Illustrates and describes the making this branch a six-track line, and the abolishing of all grade crossings. Eventually it will be electrified. 600 w. Ry Age Gaz—Jan. 28, 1910. Serial. 1st part. No. 11304.

Roundhouses.

The New Shops of the Austrian State Railways at Attnang-Puchheim (Die neue Zugförderungsanlage in der Station Attnang-Puchheim der k. k. österr. Staatsbahnen). Edward Popper. Describes the roundhouse, turntable, shop, coaling and water towers, etc. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 15, 1910. No. 11901 D.

Stations.

The Design of the Stations on the Evanston, Ill., Track Elevation work; C., M. & St. P. Ry. E. O. Greifenhagen. Explains reasons for the location and designs adopted, describing the general features. Ills. 3000 w. Eng News—Feb. 17, 1910. No. 11646.

See also Reinforced Concrete, under CIVIL ENGINEERING, Construction.

Surveying.

The Transcontinental Railway Survey of Australia. Discusses the recently completed 1070-mile survey for a proposed line to connect the State of Western Australia with the four other States. 1500 w. Engr, Lond—Feb. 4, 1910. No. 11621 A.

Switches.

The Facing Point-Lock. W. H. Arkenburgh. Describes an improved arrangement for mechanically interlocked switches explaining its advantages. 2000 w. Ry Age Gaz—March 4, 1910. No. 12126.

Terminals.

Proposed Rearrangement of Railway Terminals in Chicago. Describes a plan for the entire rearrangement of the railway passenger terminals and the establishment of a large union station. Also editorial. 1400 w. Eng News—Feb. 24, 1910. No. 11879.

Ties.

Concrete Ties for Railroads. Illustrates and describes types. 1000 w. Ry & Loc Engng—March, 1910. No. 12116 C.

A Combination Steel and Concrete Tie on the Pittsburg, Fort Wayne & Chicago Ry. Illustrated description of the Riegler tie in experimental use. 600 w. Eng News—Feb. 17, 1910. No. 11649.

Two Foreign Developments in Railway Ties. Describes two recent developments, one of concrete ties made in vibrating molds; the other a compound tie of wood and steel. Ills. 1000 w. Eng News—Feb. 17, 1910. No. 11648.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Track Construction.

Track on German Railways. Notes from a paper by Mr. Blum describing German practice, with observations by W. C. Cushing. Ills. 3000 w. Eng Rec—Jan. 29, 1910. No. 11316.

Track Maintenance.

The American Railway Engineering and Maintenance of Way Association. W. D. Pence. A brief account of the work and of the history of the association. 2000 w. Wis Engr—Feb., 1910. No. 12010 D.

Tunnels.

The Reduction of Ruling Grade in Mountain Railway Tunnels (Die Verminderung der Höchsteigung in Tunneln der Gebirgsbahnen). R. Sanzin. Discusses the reduction in tractive power in long tunnels and the necessity of reducing grades. 3200 w. Zeitschr d Ver Deutscher Ing—Jan. 29, 1910. No. 11946 D.

TRAFFIC.

Car Interchange.

Freight Car Interchange Inspection. Jno. J. O'Brien. Discusses the conditions under which cars are interchanged, some special arrangements between lines, rules, and related matters. 7800 w. Pro St Louis Ry Club—Jan. 14, 1910. No. 11815.

Car Interchange Past, Present, and Future. W. O. Thompson, with discussion. A short paper introductory to a lengthy discussion. 14500 w. Pro Cent Ry Club—Jan. 13, 1910. No. 11812 C.

Explosives.

The Testing of Explosives for Sensitiveness to Shock by the Drophammer Method. Dr. H. Kast. Trans. from *Zeit für das gesamte Schiess- und Sprengstoffwesen.* States the conditions to be complied with, and describes the apparatus used in the Military Experimental Bureau for testing sensitiveness. 1500 w. Jour Fr Inst—Feb., 1910. No. 12019 D.

Freight.

Fast Freight Lines. G. G. Huebner. Considers the through service prior to their organization and present day freight lines. 3500 w. Ry Age Gaz—Feb. 11, 1910. No. 11564.

Bulk Freight Traffic (Beförderungswege für Massengüter). Herr Cauer. Refers to conditions in Germany. Discusses freight rates, rail and water traffic, etc. Discussion. 13000 w. Glasers Ann—Jan. 1, 1910. No. 11789 D.

Freight Handling.

Mechanical Handling of Freight at Transfer Stations. H. McL. Harding. Illustrated description of a typical transfer station at Toledo, Ohio. 4500 w. Ry & Engng Rev—Feb. 12, 1910. No. 11557.

MISCELLANY.

Accounting.

Equipment Depreciation and Renewal. William Mahl. Gives statements showing the number of locomotives and cars vacated in each of eight years, the amount credited to the replacement fund, the amount charged to operating expense and the amount of salvage, with discussion of the data. 2000 w. Ry Age Gaz—March 4, 1910. No. 12124.

Austria-Hungary.

The Railways of Austria and Hungary. Editorial on the conditions under which the railways are managed as based on information in a recent report to the Board of Trade. 2500 w. Engng—Feb. 11, 1910. No. 11856 A.

Belgium.

Lines of Local Interest in Belgium (Die belgischen Vizinalbahnen). A. E. Ziffer. Outlines their development and discusses their economic importance. 10000 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens—Jan., 1910. No. 11746 F.

Central America.

See South America, under MISCELLANY.

Education.

See same title, under INDUSTRIAL ECONOMY.

France.

The Purchase of the Lines of the Western Railway of France (Le Rachat du Réseau des Chemins de Fer de l'Ouest). P. Maurice. Discusses the terms of the purchase of this railway by the French Government. 4700 w. Génie Civil—Jan. 1, 1910. No. 11731 D.

German East Africa.

Our Railways in Togo (Unsre Eisenbahnen in Togo). Carl Mosig. Describes existing and projected lines, rolling stock, etc. Ills. 6300 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1910. No. 11935 D.

Government Control.

Government Regulation of Railway Corporations. Emory R. Johnson. From an address before the Economic Club of N. Y. Discusses the legislation proposed by the President. 3000 w. Ry Age Gaz—Feb. 11, 1910. No. 11561.

Government Ownership.

See France, under MISCELLANY.

Management.

Railroad Administration. Albert J. Himes. Calls attention to some of the features deserving first attention by the beginner. 4000 w. Cornell Civ Engr—Feb., 1910. No. 12004 C.

The Unit System of Organization. Charles Hine, with discussion. Explains the details of the unit system of organization that is being installed on the Harriman lines, showing what has been accomplished. General discussion follows. 11000 w. Pro W Ry Club—Jan. 18, 1910. No. 11813 C.

The Organization of the Mechanical Department, New York, New Haven & Hartford. George L. Fowler. Gives an analysis of the organization, explaining methods followed to provide direct communication between every shop and the mechanical superintendent. 10000 w. Ry Age Gaz—March 4, 1910. No. 12129.

The Division Superintendent's Office and the Superintendency. C. A. Candee. Considers the reports, files, agreements, records, and other work of the clerical department. 4500 w. Ry Age Gaz—Feb. 11, 1910. No. 11559.

Panama.

The New Panama Railroad. R. F. Hoffmark. From the *Purdue Engng. Rev.* Explains the reasons why relocation was necessary and describes the line. 2500 w. Ry Age Gaz—Feb. 11, 1910. No. 11560.

Reports.

Making a Railway Report. Charles F. Speare. Suggestions for such reports and the features that all reports should contain. 2200 w. Ry Age Gaz—Feb. 25, 1910. No. 11898.

Russia.

Russian Railways in Asia (Russlands Eisenbahnen in Asien). A brief review of the railways financed and controlled by Russia. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Jan. 1, 1910. No. 11799 D.

South America.

Railways in Central and South America. Explains the reasons for the lack of through routes, and gives information from a recent bulletin of the International Bureau of American Republics. Maps. 3000 w. Ry Age Gaz—Feb. 25, 1910. No. 11899.

Valuation.

Valuation of Railways in Washington. J. C. Lawrence. Explains methods used to determine the value, the determination of the reasonableness of rates, and the conclusions. 5000 w. Ry Age Gaz—Feb. 18, 1910. No 11665.

Valuation and Rate Regulation. Editorial discussing the conclusion of the Washington Railway Commission. 3500 w. Ry Age Gaz—March 4, 1910. No. 12123.

Welfare Work.

See same title, under INDUSTRIAL ECONOMY.

STREET AND ELECTRIC RAILWAYS.

Accounting.

The Electric Railway Auditor, His Duties and Relation to the Organization. W. B. Brockway. Read before the Am. St. & Int. Ry. Acc. Assn. Discusses the duties and requirements of the head of the accounting department, his responsibilities, etc. 3500 w. Jour of Acc—Feb., 1910. No. 11816 C.

Austria.

The Trient-Malé Electric Railway and the Trient Electric Power Stations (Die elektrische Lokalbahn Trient-Malé und die neuen Elektrizitätswerksanlagen der Stadtgemeinde Trient). Paul Dittes. Illustrated detailed description of this line in the Austrian Tyrol. Serial. 1st part. 4500 w. Zeitschr d Oest Ing u Arch Ver—Jan. 28, 1910. No. 11797 D.

Car Inspection.

Daily Inspection and Up-Keep of Rolling Stock. H. H. Buckman. Abstract of a paper read before the Cent. Elec. Ry. Assn., Columbus, O. Discusses important items in the up-keep of equipment. 3000 w. Elec Ry Jour—Jan. 29, 1910. No. 11311.

Cars.

New Pay-as-You-Enter Cars for the Public Service Railway, Newark, N. J. Illustrated detailed description. 1200 w. Elec Ry Jour—Feb. 12, 1910. No. 11578.

Trailer Motor Cars in Philadelphia. Illustrates and describes the rebuilt single-truck open trail cars and their equipment. 1200 w. Elec Ry Jour—Feb. 26, 1910. No. 11802.

A New Storage-Battery Street Car. Illustrated description of the car to be tested in New York, equipped with the latest form of the Edison storage battery. 1200 w. Sci Am—Feb. 5, 1910. No. 11403.

Controllers.

New York Subway Control. W. B. Kouwenhoven. Considers the duties of the motorman in operating the equipment and in remedying troubles that may arise. 2500 w. Ry & Loc Engng—Feb., 1910. No. 11454 C.

Electric Traction.

The Future of Electric Traction on Railways. Philip Dawson. Discusses briefly the continuous-current and the single-phase systems. 2000 w. Elec Rev, Lond—Feb. 18, 1910. No. 12051 A.

Electric Traction on City and Suburban Railways. H. M. Hobart. A lecture at the School of Military Engng., Chatham. Discusses the advantages of electric traction which have led to its extensive use in a wide field of railway work. 4000 w. Tram & Ry Wld—Feb. 10, 1910. No. 11887 B.

A General Method of Dealing w'th Traction Problems in Railway Operation (Allgemeines und umkehrbares bildliches Staffelverfahren zur wechselseitigen Ermittlung sämtlicher Zugförderungsgrössen im Bahnbetriebe). Artur Hruschka. Mathematical discussion of the influence of the various factors. Ills. Serial. 1st part. 3000 w. Elek Kraft u Bahnen—Jan. 14, 1910. No. 11916 D.

Instruction Cars.

Re-Equipped Elevated Instruction Car of the Brooklyn Rapid Transit System. Illustrated detailed description. 1200 w. Elec Ry Jour—Feb. 5, 1910. No. 11443.

Interurban.

Lewiston, Augusta & Waterville Street Railway. Illustrated description of an interurban line in Maine, operating 140 miles of track. 5500 w. Elec Ry Jour—Jan. 29, 1910. No. 11310.

Locomotives.

New Electric Locomotives for the New Haven Railroad. N. W. Storer. Illustrated description of recently completed locomotives, tested with remarkable success. 1500 w. Elec Jour—Feb., 1910. No. 11999.

Railless.

Railless Electric Traction. R. Lonneman. Illustrated description of the electric trolley system without rails. 1500 w. Cassier's Mag—Feb., 1910. No. 11674 B.

Mercédès-Stoll Automobiles for Railless Electric Traction (Automobiles a Trolley aérien Système Mercédès Electrique Stoll). Illustrated description, with data of railless trolley lines in Austria. 1500 w. Génie Civil—Jan. 8, 1910. No. 11734 D.

Single-Phase.

The Padua-Fusina Single-Phase Line (Ferrovia a Trazione elettrica monofase Padova-Fusina). Describes briefly the line and equipment. Ills. 2500 w. Ing Ferro—Jan. 1, 1910. No. 11745 D.

Stray Currents.

Electrolysis by Earth Currents. William A. Del Mar. Explains the new conception of electrolysis which is a reversal of the views usually held. 3000 w. Elec Wld—Feb. 17, 1910. No. 11643.

Subway Signaling.

Signal System of the Hudson & Manhattan R. R. John Leisenring. Illustrated description of the signal system in the downtown tunnels. 1500 w. Sig Engr—Feb., 1910. Serial. 1st part. No. 11697.

Switches.

Electric Switch Operating Mechanism for Street Cars (Elektrische Weichenstellvorrichtung für Strassenbahnwagen). C. Werner. Describes devices produced by the Siemens-Schuckertwerke. Ills. 2500 w. Elek Kraft u Bahnen—Jan. 4, 1910. No. 11914 D.

Switzerland.

The Bellinzona-Mesocco 1500-Volt Railway. Illustrates and describes interesting features of this line. 1000 w. Elec Ry Jour—Feb. 19, 1910. No. 11657.

Track Maintenance.

The Effect of Electrical Operation on the Permanent-Way Maintenance of Railways. Charles Augustus Harrison. 2500 w. Elec Age—Jan., 1910. No. 11309.

Trolley Lines.

Notes on Tramway Overhead Equipment. H. Dudgeon. Notes on overhead work, considering the various strains encountered. 1500 w. Elec Rev, Lond—Jan. 28, 1910. Serial. 1st part. No. 11527 A.

The Experimental Catenary Line of the Connecticut Company. An illustrated account of an elaborate service test of catenary suspension systems on a line between Middletown and Hartford, Conn. 4000 w. Elec Ry Jour—Feb. 26, 1910. No. 11893.

Electric Traction on the New Boulevard Lille-Roubaix-Tourcoing (La Traction électrique sur le nouveau Boulevard Lille-Roubaix-Tourcoing). A. Bidault des Chaumes. Illustrated description of the line and its equipment. 4000 w. Génie Civil—Jan. 1, 1910. No. 11730 D.

York, England.

York Electric Tramways. An illustrated account of the electrification of the tramways, using the trolley system. 2500 w. Tram & Ry Wld—Feb. 10, 1910. No. 11886 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard *w* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal *w* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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Valve Setting. By Hubert E. Collins. Size, 9 by 6 in.; pp., 209. Ills. Price, $2. New York and London: Hill Publishing Company.

Fire Tests with Fire Extinguishers. Size, 8½ by 5½ in.; pp., 16. Ills. Price, 2/6. London: The British Fire Prevention Committee.

Natural Sources of Power. By Robert S. Ball. Size, 8½ by 5½ in.; pp., xvi, 348. Ills. Price, $2. New York: The D. Van Nostrand Company.

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Railroad Engineering. By Walter Loring Webb. Size, 9½ by 6½ in.; pp., 296. Ills. Price, $3. Chicago: American School of Correspondence.

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The Steam Turbine. By James Ambrose Moyer. Size, 9 by 6 in.; pp., 370. Ills. Price, $4, 17/-. New York: John Wiley & Sons; London: Chapman & Hall.

Gold Refining. By Donald Clark. Size, 8½ by 5½ in.; pp., 123. Ills. Price, 12/6. Sydney: Australian Mining Standard; London: Sir Isaac Pitman & Sons.

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Road Preservation and Dust Prevention. By William Pierson Judson. Size, 9 by 6 in.; pp., 144. Ills. Price, $1.50. New York: The Engineering News Book Department.

Laboratory Notes on Industrial Water Analysis. By Ellen H. Richards. Size, 9 by 6 in.; pp., 49. Price, 50 cents, 2/-. New York: John Wiley & Sons; London: Chapman & Hall.

Bricklaying System. By Frank B. Gilbreth. Size, 9 by 6 in.; pp., 321. Ills. Price, $3. New York and Chicago: The Myron C. Clark Publishing Co.; London: E. & F. N. Spon.

Electric Power Conductors. By Wm. A. Del Mar. Size, 7½ by 5 in.; pp., 339. Ills. Price, $2. New York: The D. Van Nostrand Company; London: Crosby Lockwood & Son.

Structural Details or Elements of Design in Heavy Framing. By Henry S. Jacoby. Size, 9 by 6 in.; pp., 368. Ills. Price, $2.25, 9/6. New York: John Wiley & Sons; London: Chapman & Hall.

Smolley's Parallel Tables of Logarithms and Squares. By Constantine Smolley. Size, 7 by 5 in. Price, $3.50. New York: The Engineering News Publishing Company; London: Archibald Constable & Co.

Analysis of Mixed Paints, Color Pigments and Varnishes. By Clifford Dyer Holley and E. F. Ladd. Size, 8½ by 5½ in.; pp., xi, 238. Ills. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

Report of the Proceedings of the Forty-third Annual Convention of the Master Car Builders' Association held at Atlantic City, N. J., June 21, 22, and 23, 1909. Size, 9 by 6 in.; pp., 681. Ills. Chicago: Published by the Association.

Report of the Proceedings of the Forty-second Annual Convention of the American Railway Master Mechanics' Association held at Atlantic City, N. J., June 16, 17 and 18, 1909. Size, 9 by 6 in.; pp., 403. Ills. Chicago: Published by the Association.

Locomotive Dictionary, 1909 Edition. Compiled for the American Railway Master Mechanics' Association by George L. Fowler. Size, 12 by 8 in.; pp., 539. Ills., 5,266. Price, $16. New York: The Railroad Age Gazette.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION.

By H. L. Gantt.

IV. FIXING HABITS OF INDUSTRY.

The preceding papers in Mr. Gantt's series, which began in our February issue, showed how the efficiency of workers under either day-work or piece-work systems of payment must be influenced by the mode of management and individual compensation adopted. They proceeded then to a demonstration of the effectiveness of the policy of an established "task and bonus," properly introduced and administered. The third article showed how the task and bonus could be properly determined and administered. We now pass to actual results secured in a variety of cases, under differing conditions, with all the essential detail of each workman's record. By graphic representation in two colors, the tendencies and the outcome (both individual and average) are made strikingly evident, while Mr. Gantt's own critical comment multiplies the value of the charts to every employer of labor. A concluding chapter next month will show the relation of these results to the great purpose of manufacture—Profits.

In answer to many inquiries we are glad to announce that Mr. Gantt's entire series, with much additional introductory matter and amplified comment, will be republished shortly in book form by THE ENGINEERING MAGAZINE.—THE EDITORS.

IN the pursuit of the study of the possibilities of performance by workmen, I have done much to train and educate them, and consequently have seen the far-reaching results that would follow if manufacturers in general would adopt a policy of educating and training the workmen they need. A paper on Training Workmen in Habits of Industry and Co-operation, read by me before The American Society of Mechanical Engineers in December, 1908, was written to explain the advantages of such a policy. Since that paper was written additional results have been obtained, which, when studied in detail, illustrate those advantages even more forcibly.

About five years ago I was engaged by a cotton mill to take up the question of making their labor more efficient, but as they were very conservative people we proceeded slowly. The superintendent and foremen were most of them English or Scotch, who were satisfied that the way they had done things in the old country was all right, and they objected to any change. The work proceeded very slowly indeed, but we gradually succeeded in getting our time and record system established and then a reliable cost system soon followed. We were, however, unable to do anything for a long time that had any great effect on the work itself, and after we had succeeded in getting the cost system in operation I told the treasurer that we had done about all that was possible under the conditions existing. The little that had been done, however, was so beneficial that in April, 1908, the treasurer asked me to come and finish up the job, saying that he now had a new superintendent who was in sympathy with the work, and that the worst foremen were gone.

During the year or more during which I had not visited the mill, attempts had been made to extend the work already started, but from lack of experience on the part of those engaged in it, practically no progress had been made.

When I took it up again my instructions were carried out conscientiously, and men detailed for the work were kept on it continuously.

Twelve new looms had recently been installed in the weave room, and as soon as a competent man could be got we began to study how to run these looms most efficiently. A pick counter was put on each loom, and the best weaver in the room (a Pole named Samtak) was given four of them to run.

A trained observer with a stop watch stood by the weaver and studied all his motions in detail. He learned how this skilful weaver stopped and started his loom, how he removed the empty bobbin from the shuttle and put a new one in, how he tied the knot. From these observations he found out how much time it was necessary for the loom to be stopped in a day, and consequently what proportion of the time it should be actually weaving. No time was allowed for "loom out of order," or "no filling," or any other cause that might be eliminated. Steps were taken to be sure that the loom was in good order and that proper filling should always be on hand, and a task was set on the supposition that all removable obstacles would be removed. This task was fixed as the number of picks the loom should throw provided these unnecessary delays were eliminated, and a substantial bonus was offered for its accomplishment. It was expressed as a percentage of the total number of picks the loom would throw if it ran constantly all day without any stop. It is interesting to note that the task was greater than the best weaver had been able to accomplish regularly before we had made special provision to remove the obstacles. Having decided upon the task, three of the next best weavers in the room were chosen to do it and Samtak was the instructor to teach them how.

The three men chosen are those whose names are at the top of Chart I (facing page 164). They were all Greeks, speaking almost no English. The instructor, Samtak, is a Pole, whose English is not very good, and who could make himself intelligible to the Greeks only by signs. The first man, Papadimitri, declined to work under instructions and on task work. He was not discharged but allowed to work his own way until he should see where his interest lay. We therefore had Samtak give all of his attention to the other two, our observer, who had studied Samtak's work, being constantly on hand keeping a record of the number of picks each loom threw per hour, and removing the obstacles to the men's performing the task. Both men failed to earn a bonus on the first day—this is shown by the red mark—but on the next two days they came so near it that it was allowed them, and they got a black mark.

Our observer, however, satisfied himself that failure to perform the task was due to the fact that the warps and filling were not coming in a satisfactory manner, and that some of the looms were not just right. He accordingly ceased for a time to urge the men to perform the task and devoted his attention to getting things in such a condition that these obstacles would be removed. The black cross shows that the men were on day work and were making no special effort to perform a task. At the end of eleven days our observer felt that conditions were all right and he started the men again. Papadimitri by this time had concluded that we were going to "play fair" and wanted to start too. The black lines on the chart show how soon all began to make their bonus pretty regularly.

It was necessary, however, for our observer to be constantly on hand and to keep a record of their work hour by hour, for he would frequently find some loom falling behind, which, if not looked after would cause the weaver to lose his bonus. Whenever he found a loom not doing all it should he called Samtak's attention to it, with the result that the cause was soon discovered and removed; but Samtak seldom at first noticed a lagging loom. Again, Samtak was at first very slow at making any complaint if anything was wrong, but the example of our instructor and the incentive of a bonus of 6 cents for each weaver who made his bonus, and 10 cents each if *all* made bonus, gradually taught him to look out for their interests and his own. It took the entire time of our observer for several weeks to get the conditions such that no obstacle would arise which Samtak could not remove. It must be remembered that while Samtak was a good weaver, he was not a teacher. He had in the past been trained not to object when things went wrong, but to do the best he could without complaining. Even with the example of the instructor and the incentive of a bonus, it was some time before he realized that we really intended that he should assert himself.

We began to study the looms about the first of June, and started the first task workers early in July, but it was nearly the middle of August before we were ready to start others on task work. By this time other weavers were willing to try, but it required the attention of both Samtak and our observer to get these men going right. It took the first two of these men about three weeks to become skilful enough to do the task, but the third, fourth and fifth did it from the start. During September and October we put on several more who gradually became proficient.

By this time we had gotten all of the best weavers on task work, and henceforth we had to train the poorer ones, which partially accounts for the sudden increase of red marks. Another cause for this increase was the fact that several trained weavers left. They had not yet become convinced that we were going to treat them fairly, and left for some insignificant cause. The dropping out of these men shows the importance of time in doing this work. Until the workmen become thoroughly satisfied through their own experience that the job they have is the best one they can get, they may be stampeded by a very slight cause.

Our gang had now become too large for Samtak, whose allotment was twelve weavers; and we started another gang, placing in charge of it the weaver Shea, whose name indicates his nationality. He was the only bonus weaver who could speak English.

While there are some exceptions the chart has a tendency to become blacker slowly as time progresses.

Chart II* shows the record of Samtak's gang from March 1 to October 9, 1909. This chart distinctly blackens as time progresses. This means more than that the men have acquired the skill to do the work. They have acquired the habit of working steadily and keeping

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* Chart II is placed below Chart I, on the same sheet, facing this page.

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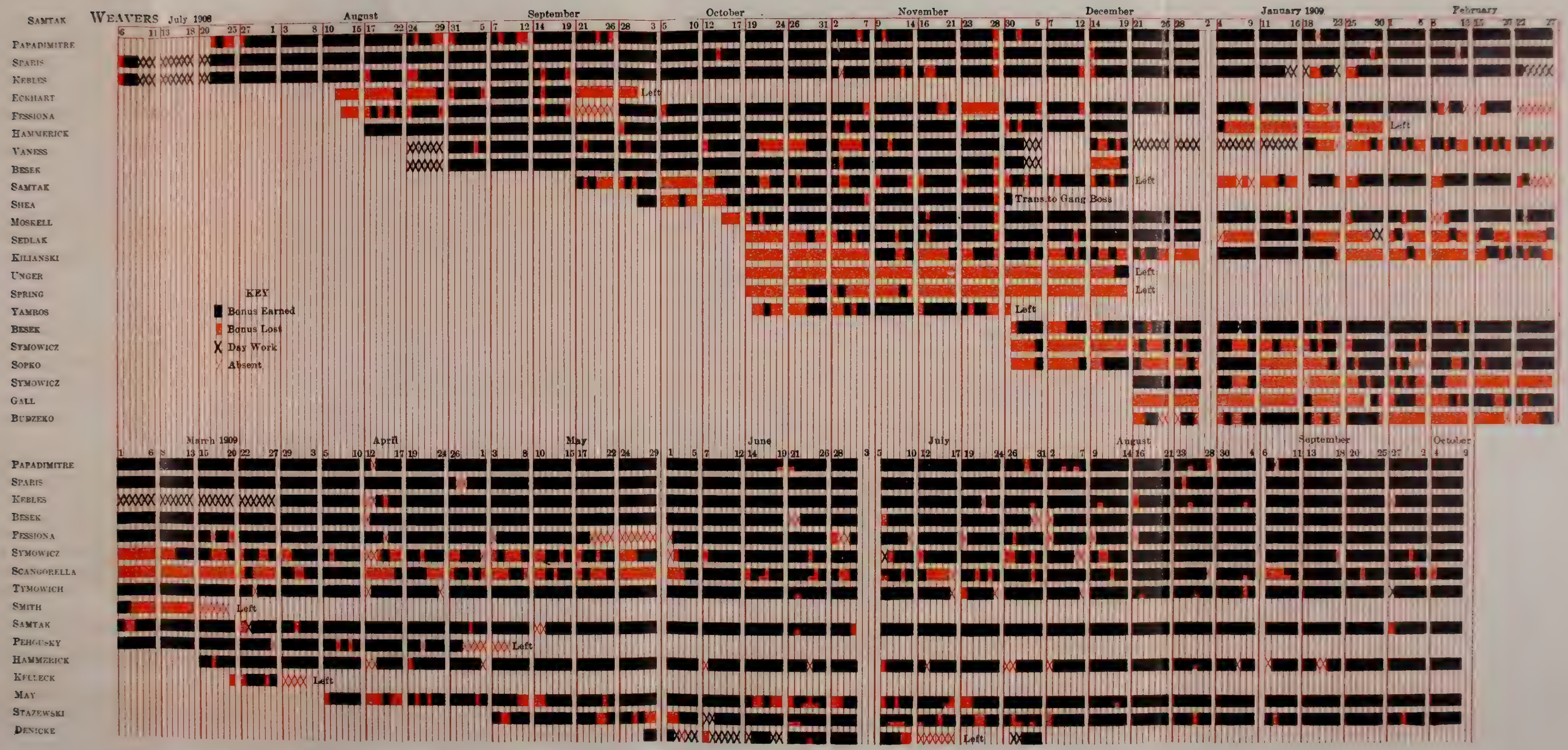

CHART I. TASK AND BONUS SYSTEM IN A WEAVE ROOM. NOTE THE INCREASE OF BLACK (MEANING TASK ACHIEVED AND BONUS EARNED) AS TIME PROGRESSES.
CHART. II. THE RECORD OF THE SAME ROOM CONTINUED THROUGH THE FOLLOWING EIGHT MONTHS. THE HABIT OF INDUSTRY HAS BECOME FIXED.

their attention on their work. The red crosses signifying absence are notably lessened. These men have not only improved in skill, but in habits of industry; and the gang boss Samtak is not their driver, but their helper and friend. The blackening of the chart signifies not only that more work is done, but that it is done better, for *black* means that both quantity and quality are up to the standard. There is one man in the group whose history is worth studying, namely the weaver Samtak, brother of the gang boss. Note that he began on this work on September 21, 1908. He was a good weaver who had been working in the mill off and on for several years. His temper is such that he was liable to leave on the slightest pretext, but in a few weeks or months would come back for a job, probably having left his new job for some similar slight cause.

He would not do task work at first, although offered a chance, but took hold when he found others profiting from it. The old habit, however, of quitting on a slight pretext was still on him, and he left before Christmas. By the first of the year he was back, but he had lost his ability to make his bonus, and he spent nearly two weeks before he earned it a single time. Note also that he was absent three days in the first two weeks. Was he again looking for another job? His actions during this time indicate an unsettled frame of mind. Again in the latter part of February the *wanderlust* came over him. Early in May he again had a slight attack, possibly of "spring fever." Since that time he seems to be entirely cured.

We knew this man and understood his moods, and we know what kind of a change has taken place. Have not many others been influenced in the same manner?

In considering this work an important element to be noted is the time needed. When we began our study in June, 1908, we already had in operation means for learning how long each worker spent on every job and how much work was done. There was also in existence a system of laying out the work from the office. In other words, the general mechanism of our system was in operation and working smoothly, yet it was several months before we got enough task work going to make any real show. If we had attempted to introduce it much faster we should have met with two difficulties. First, it would have been impossible for us to remove all the obstacles for a large number of weavers. Second, the poor weavers would probably have persuaded the good ones not to try to do as we wished. The best evidence of this is that Papadimitri, one of the very best weavers, declined to do the work at first.

Time is needed to overcome prejudice and to change habits. This is a psychological law, and its violation produces failure, just as surely as the violation of the laws of physics or chemistry.

Chart III* represents our progress in training workers to do their task in winding weaving bobbins—bobbins of filling that go into the shuttles. Each operative tends a number of spindles, and the work consists first of taking out full bobbins and putting empty ones in place; second, removing empty spools from which the yarn has been taken, and replacing them with full spools. In as much as the machine runs at a constant speed, the bobbins fill and the spools empty more rapidly with coarse yarn than with fine; hence it was necessary to make a careful detail study of the subject to set a proper task for different sizes of yarn. This study took about six weeks, and having settled upon proper tasks, we started a girl named Wagner on task work early in February. She would not do it at first but staid home for a week. At the end of that time she came to work willing to do as we wished, and was evidently surprised at the ease with which she succeeded. On March 1 we began to keep the charts. At that time those doing the task as shown by the chart represented but a small proportion of the whole number of workers. Our gang boss, McCabe, received 5 cents for each worker that made a bonus and 10 cents each if all made it. Our observer was constantly on hand, at first, to help him remove obstacles, and to see that the workers had every opportunity to work efficiently. In spite of this a large proportion of the first ones failed to earn the bonus regularly and gradually left. Many of these were girls who evidently found continuous attention to their work irksome, and even though they were capable of doing the work, preferred the more free and easy method to which they had been accustomed. Others showed but little ability to do the work or to learn. The fact, however, which is evident from the chart—that the larger the number of bonus workers in the mill, the faster the new ones learned—is a matter of great psychological importance. *There is in every workroom a fashion, or habit of work, and the new worker follows that fashion, for it isn't respectable not to.* The man or woman who ignores fashion does not get much pleasure from associating with those that follow it, and the new member consequently tries to fall in with the sentiment of the community. Our chart shows that the stronger the sentiment in favor of industry is, the harder the new member tries and the sooner he succeeds. We must therefore make our compensation such as to encourage the habit, or fashion, of industry; and our charts show to what extent we have succeeded in fixing this habit.

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* Chart III is inserted between pages 168 and 169.

It is interesting to note that although failures most frequently occurred on Monday, even this habit could be cured.

The mill shut down for about three days about July 4 to take stock, and as we had just gotten this room in good shape, that little vacation may be used as a dividing line on this chart. Remembering that solid black indicates that the full amount of work has been done, and that all of it was up to standard for quality, while solid red represents that the work was below standard either for quantity or quality, and sometimes for both; also that the black cross means the worker was doing day work, while the red cross means that the worker was absent, the amount of black on any day is a measure of efficiency for that day and the red is a very accurate measure of the amount of supervision needed, for all cases of failure to perform the task must be investigated, and all cases of absenteeism should be inquired into. The gradual change of the chart from red to black means not only that the workers are becoming more skilful and regular in their habits, but that the machinery is being kept in better order, for the task is so set that unless the machines are in good condition the bonus cannot be earned.

Since July 4, not only has the amount of supervision needed been diminished and a regular output maintained, but the workmen been much more regular in attendance and none have left. The indications of the chart are that the output of the room since July 4 has been larger, better and more uniform. It is now easy to predict the daily output and to make promises of delivery that will be kept without special effort on the part of the foreman. Before July 4 such predictions were only estimates, and a proper output was kept up only by constant supervision. As the gang boss in this room gets a bonus of 5 cents for each worker who earns a bonus, and 10 cents each if all earn bonus, it is easy to see that the superintendent does not have to worry much either about the quantity or quality of the product. It is easy to measure the quantity, and the quality is taken care of more easily still, for the weaver who gets poor bobbins refuses to use them.

Chart IV* represents girls winding yarn on spools. Note that it was the fashion among these not to try for the bonus on Saturday. Most of them could earn it every day if they chose, but there was evidently a feeling against working hard on Saturday.

Note that on March 6 two girls tried to break this precedent, but it was too strong, and on March 13 all failed. On March 20 another tried. On March 27 one of the first two tried again, but after that all gave it up for three weeks. Then our first two evidently decided that they would defy public opinion, which they did pretty successfully until June 6, when apparently by common consent all "took it easy." After that, however, all gradually fell into line and the Saturday inefficiency disappeared as did the Monday inefficiency on Chart III.

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* Charts IV and V, on one sheet, are inserted between pages 172 and 173.

Chart V* represents girls inspecting cloth and mending slight defects in weaving, trimming ends, etc. This is high-grade work and all defects must be eliminated. We started the task after careful study, and while most the girls showed the ability to perform the task only two did it with any degree of regularity. On April 7 three left because they were unwilling to maintain the high standard of quality that had been set. The chart shows the difficulty of getting new ones to do the work. Fortunately the three dissatisfied ones came back for their jobs in a few days, and soon became better than ever. These inspectors were supplied with work and had the heavy cloth handled for them by the three men whose names are at the top of the chart. Each of these men received two cents for each girl that made a bonus. Early in July it was decided to give the boss weaver, who has not yet been mentioned, a bonus. He is an excellent man and was undoubtedly doing his work well, but we felt that his bonus should depend upon the quality of the work turned out. In as much as the better the cloth was when it came from the weaving room, the easier the task of the inspectors would be, we decided to make his bonus in proportion to the number of inspectors that earned theirs. The inspectors at once began to earn bonus with great regularity, for the boss weaver found that the inspectors were only too anxious to point out defects which it was to his interest to have corrected. He visits the inspecting room frequently during each day, and by the reports he gets keeps closely in touch with what his weavers are doing. The result is a continuous improvement in the quality of their work.

Taking all of these charts together we note the following: That the amount of supervision needed has diminished; that the quality of the work is better; that the quantity is greater; that the amount being turned out can be predicted accurately, and hence promises need no longer be guesses, but can be made and kept; that the workers are not only earning more money, but are acquiring better habits of work which will make them better citizens.

Chart VI (page 170) shows actual results in task work that has been going on for over two years, showing increase in output and decrease in cost. Charts similar to Charts I to V were kept for most of this work while it was being installed, and they show characteristics identical with those displayed on the charts here given. They carry ew Eng-

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* Facing page 172, on lower half of sheet.

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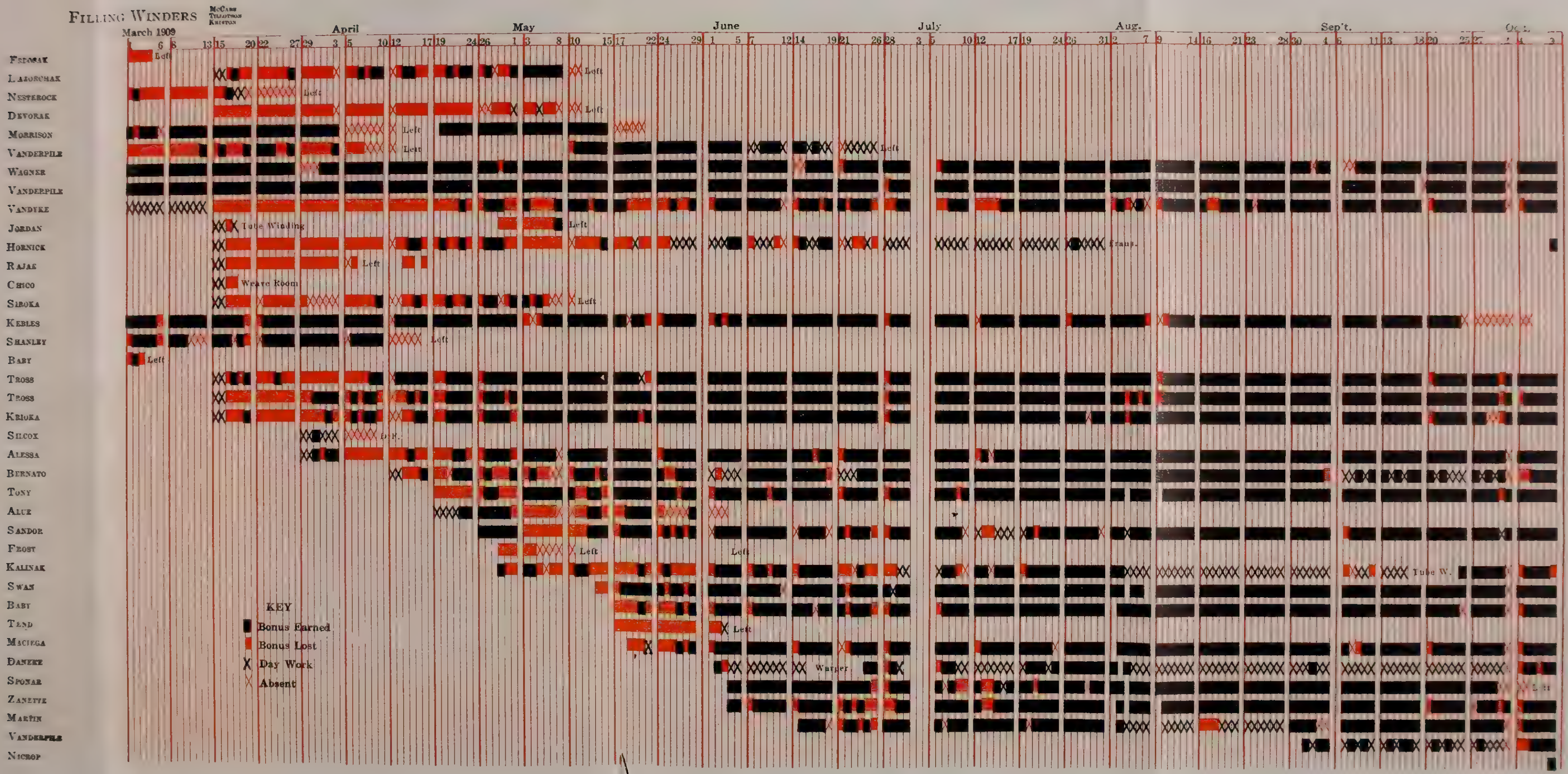

CHART III. TASK AND BONUS RECORD OF WORKERS WINDING WEAVING BOBBINS. NOTE DISAPPEARANCE OF THE HABIT OF SLACK WORK ON MONDAYS.

the records of nearly 100 people, men and women, chiefly New Englanders or French Canadians.

In this chart the heavy line marked 100 represents the output per operative and the wage cost per unit of product before we began to study the problem. Figure 1 on this chart represents the various operations in bleaching, finishing, and putting up sheeting. The ordinates of the upper heavy line measured from the base line marked 0 represent the present output per worker compared with the former output of unity, an average increase of about 80 per cent. The broken line represents the present average wages, about 40 per cent greater than the former wages. The lower full line represents the new wage cost per piece, which averages only about 60 per cent of the former wage cost. In other words, we are getting an increase in output of 80 per cent and each unit costs us only 60 per cent of what it did before. Our charts have already made it clear that the supervision needed is less, hence the profits have actually increased to a much greater degree than the charts indicate.

Figures 2, 3 and 4 on this same chart illustrate even more forcibly the effect of task work with a bonus, for in these cases the average output is in all cases more than double, and in one, the manufacture of pillow cases, more than three times as great.

The increase in the case of the pillow-case factory was so great as to indicate that the work must have been done very inefficiently before. This was undoubtedly true, but probably not more inefficiently than in many shops run by a foreman who has no special training as an executive, and of whom much more is expected than he could possibly do efficiently.

But this is not all; a fortunate set of conditions enabled us to get a measure of the improvement in quality which had been obtained. Soon after the reorganization of the pillow-case factory represented in Figure 4 on this chart got well under way, there was a serious complaint of bad work from one of the largest customers. An investigation proved that the complaint was well founded, and the customer was asked to return all the goods.

About fifty cases of goods were returned, and of course the bad work was all blamed on the new system. The inspection of the first few cases proved that the number of imperfections per case varied greatly, and it was decided to keep an exact record of what the imperfections in each case were, and whether the work was done before or after the installation of the task and bonus system. The result was as follows: In 28 cases of goods done before task work was started,

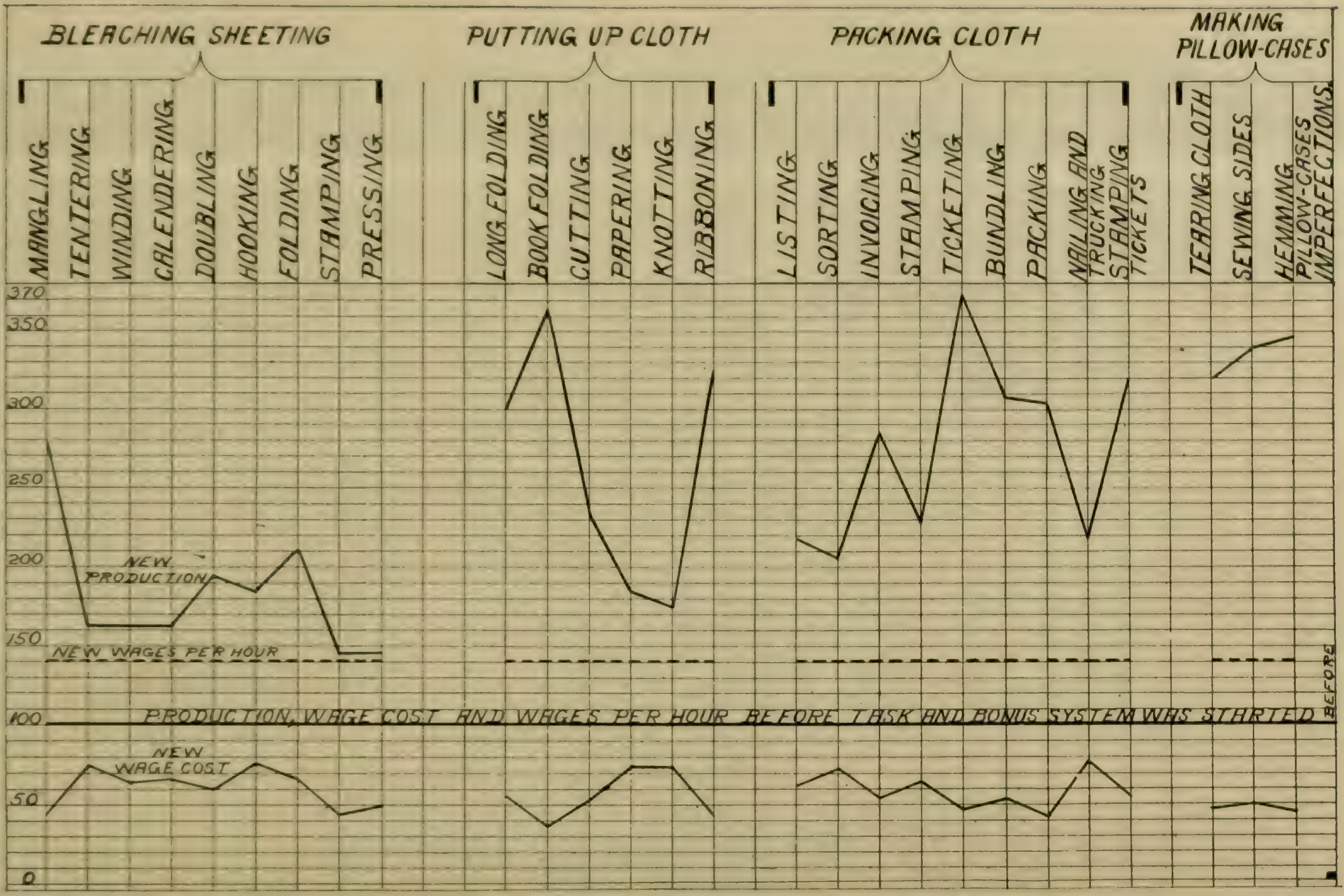

Figure 1 Figure 2 Figure 3 Figure 4

CHART VI. ACTUAL RESULTS UNDER THE "TASK AND BONUS" SYSTEM AFTER MORE THAN TWO YEARS OPERATION.

The solid line represents the regular average volume of production, wage cost per unit of product, and wage rate per hour before the system was introduced. On this as unity for each of these scales, the dotted and broken lines represent the conditions more than two years later. It will be noted that the new wage rate per hour is about 140 per cent of the old; the production has risen to a level from 155 to 375 per cent of the old; the wage cost per unit has fallen to about 60 per cent (ranging from 38 to 75 in different operations) of the old cost.

the average number of imperfections per case was 47½. In two cases done after the task work was started, but before the inspection was going properly, the average number of imperfections per case was 2. In eleven cases done under the task and bonus system after the inspection was going properly, the number of imperfections per case was less than one.

Representing by unity in Figure 4 the number of imperfections per case before the task and bonus system was started, the short line represents the number afterward—less than 2 per cent.

This improvement in quality also points to the fact that the pillow-case factory was badly run; the interesting fact is that it was possible to make such a great improvement in a few weeks.

The next question that naturally comes to one's mind is that of the permanence of these results. On this subject we have some data also.

About six years ago we began the reorganization of a packing-box factory, which made five or six hundred cases per day and was run in connection with two large bleacheries of cotton cloth. This factory had been a sore spot, and whenever shipments were delayed the box factory came in for its share of the blame. It took nearly a year to get this factory into shape, but for the past five years it has run so smoothly that the manager of the bleachery has hardly been aware of its existence. Two years ago they had in this factory seventeen bonus workers; now they have nineteen bonus workers out of a total of thirty workers.

The organization of one of the bleacheries referred to was practically completed on these lines over two years ago, and it is running today better than it did then. The management of the other bleachery is gradually being remodeled on the same lines.

The management of the pad dyeing department of a large dye works has been remodeled on these lines, with the result of practically doubling the output and distinctly improving the quality. The workmen are getting much better wages, and the costs are decidedly lower. This department has been running on these lines over a year, and is running much better today than at any time yet.

No better testimonial both to the quality of the work done and the economy with which it is being done can be had than the fact that, notwithstanding the increased output per machine, they have been obliged to add other machines to the dye works to take care of the business offered, until they are doing in this department today nearly three times what they did two years ago.

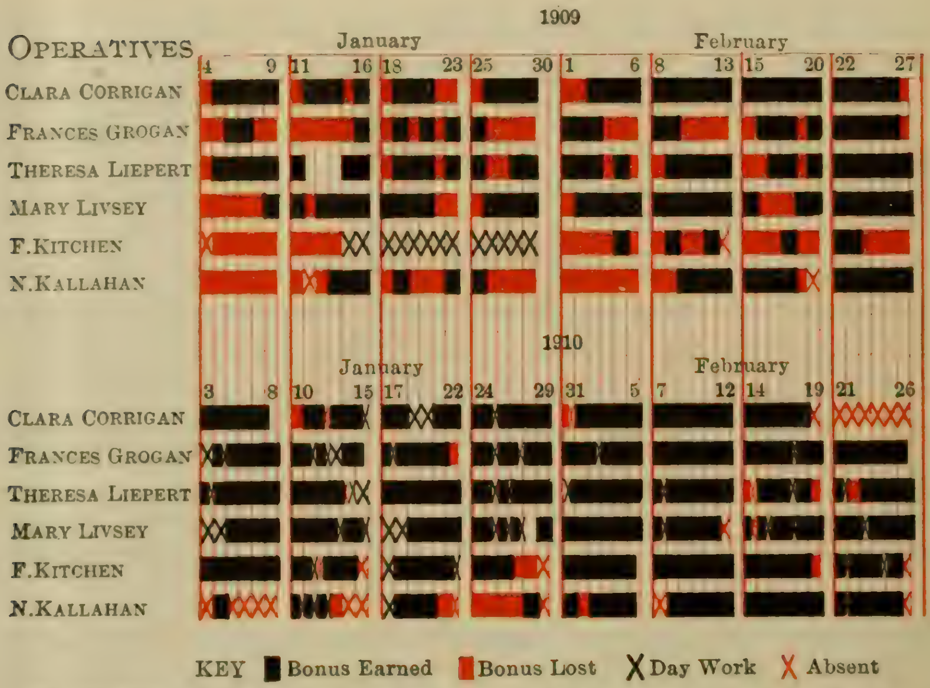

CHART VII. BONUS RECORD OF GIRLS WORKING IN A FOLDING ROOM.

The upper half shows eight weeks in 1909. The lower half, the corresponding 8 weeks in 1910. Remembering that red means bonus lost and black bonus earned, the improvement in 12 months becomes strikingly apparent.

Chart VII represents girls working in the folding room of a bleachery—not one of those previously referred to—and is interesting from the fact that they belong to an entirely different class of people from those in the cotton mill (as can be seen by their names), and also from the fact that some of these girls have often as many as ten or fifteen different kinds of work per day. In starting this group, which is much larger than the number shown here, we had exactly the same experience as with the weavers and the winders; one of the girls declined to do as we wished at first, and afterwards became one of our best workers. These three cases illustrate the fact that a worker may hesitate, or even refuse to do work by a new method, and still become ultimately a good and loyal worker under the new methods. The action of a workman when brought up against a new method is largely influenced by his temperament, or the opinions of his friends. When, however, this method has been established all the evidence available goes to show that these results are not only permanent, but that the workers become more proficient and the product better. This chart shows the improvement after a year's training. We began the task and bonus in November, 1908. The

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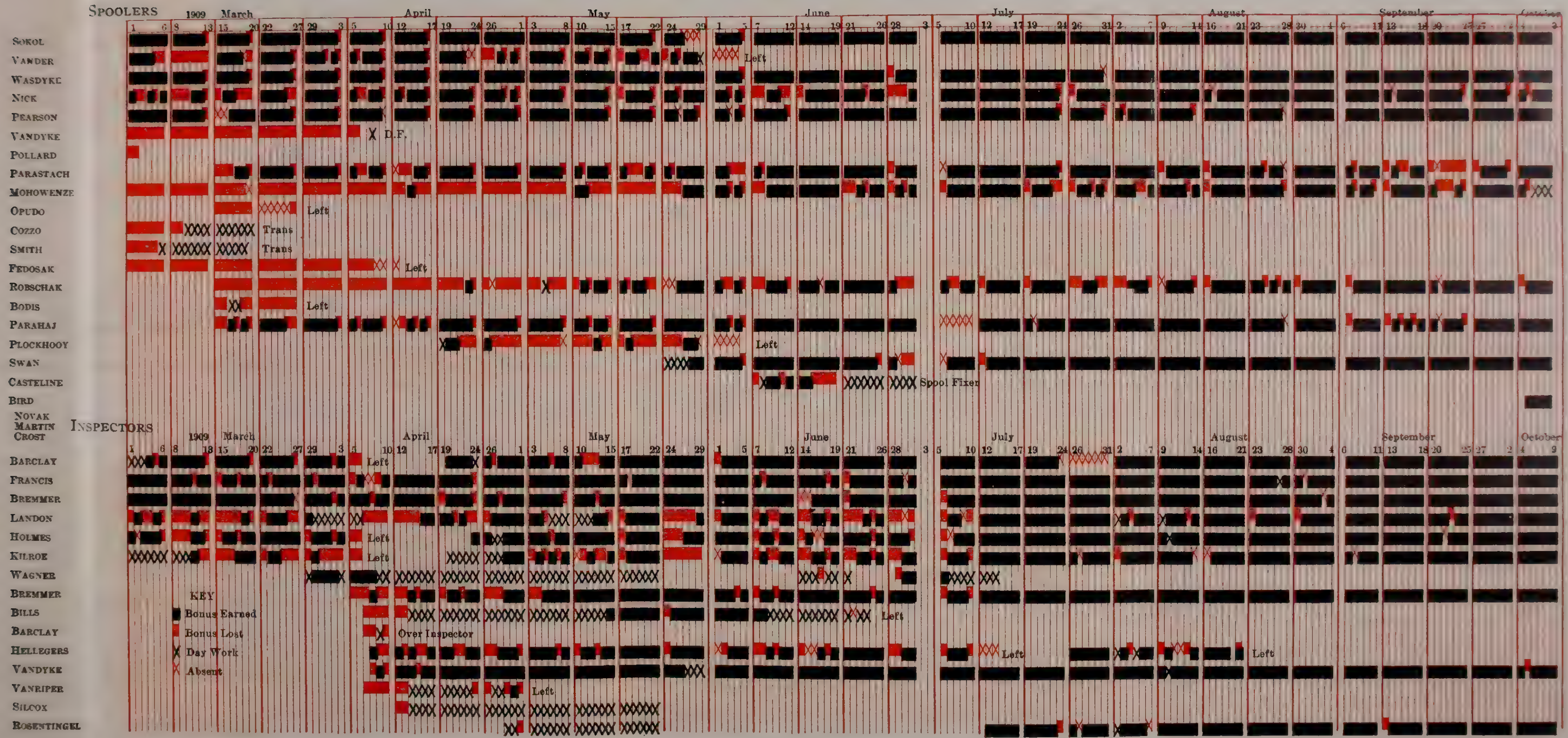


CHART IV. TASK AND BONUS RECORD OF GIRLS WINDING YARN ON SPOOLS. NOTE DISAPPEARANCE OF SLACK-SATURDAY HABIT.

CHART V. TASK AND BONUS RECORD OF CLOTH INSPECTORS AND MENDERS. NOTE IMPROVEMENT FOLLOWING ESTABLISHMENT OF BONUS TO HEAD WEAVER EARLY IN JULY.

upper section of the chart shows how the girls worked about the time the system got well started. The lower section is a record of the same girls a year later.

CO-OPERATION.—A careful analysis will show that we have established a system of co-operation, where it is to the interest of each bonus worker to do as much work as he can, and to do it as well as possible. Further, if a workman does poor work, others suffer beside himself, with the result that he either learns to do good work or finds work elsewhere. As it is to the interest of the worker to do good work, and plenty of it, he contracts the habit of doing a large amount of good work. As long as it is to his financial interest he will continue to cultivate this habit.

There are only four ways in which such a system can go to pieces.

The first way, and the one most liable to happen, is by a change of management, by which the men in authority who have been trained under these methods are replaced by men not so trained. Such men might destroy the whole structure before they knew what they were doing. This was done to a large extent at the Bethlehem Steel Works.

The second is by a desire on the part of the management to get work done more cheaply still. In this case they might do great harm by cutting wages, or increasing tasks. In as much, however, as under this system they can get work done more cheaply than their competitors can do it, they have so far been willing as a rule to let the workmen have fair wages, especially when they realize how much harder it will be to train up a new set of workmen at lower wages or more difficult tasks.

Chart V shows in a marked manner the effect of losing a few skilled workers.

The third way is for the workers to demand more wages. In as much as they are making more wages in a mill run this way than they can get elsewhere, this is not liable to happen.

The fourth way is for the business to fall off to such an extent as to give no work. Here again the plant operated in this manner will hold out longest, for costs are lower. It is also a fact, shown by experience, that if there is an increase of work it can be provided for much more readily under this system, where our trained men are capable of teaching.

While this discussion is of importance to the man considering the adoption of these methods, the most important fact for people in general is that our immigrants as well as our native people can be trained to habits of industry and made efficient, and that a scheme of co-operation can be devised that is beneficial alike to employer and employee. Further, it is of importance that when once in operation these methods are continued and perfected by the workers themselves.

If these methods were introduced extensively, it is without question that the habit of the shop would influence that of the community, and there would be a general increase in efficiency. The habits a man has to acquire to become efficient in one class of work stand him in good stead in becoming efficient in other work. These habits of work are vastly more important than the work itself, for it is our experience that a man who has become efficient in one thing, readily learns to become efficient at doing other things. The ability of such people to produce wealth is more to the country than the wealth itself. The productive power is more valuable than the product. Many of the workers represented on our charts are immigrants who cannot speak English, yet in a few months at most they become far more efficient than the average mill operative, who professes to be skilled.

It must be emphasized, however, that this training was done only by the very best workers under the direction of good teachers, that the individual was given the personal attention, day after day, of the teacher and the expert workman, and that he was assured of good compensation if he succeeded. We concentrate on the individual, but when a few have learned, and are being benefited, others are not slow to imitate. One cannot learn to do this work by reading magazine articles; it must be learned in the shop where an educated man studies the work and the workmen. When he has become familiar with both work and workmen he can make a start, but to try to do much without this kind of practical experience is about as futile as trying to learn to skate through a correspondence school.

To succeed in this work the teacher must have the ability to analyze and investigate, and must himself be trained in such habits of industry and concentration as to enable him to become master of his subject.

In his inaugural address, President Lowell, of Harvard University, emphasized the importance of hard and accurate thought in the following words:

"The student ought to be trained to *hard and accurate thought*, and this will not come from surveying the principles of many subjects. It requires a mastery of something acquired by continuous application."

If we substitute for *hard and accurate thought, hard and accurate work,* his remarks are just as true when applied to the workmen as to the student. The workman who has become master of something takes pride in his work and soon distinctly improves in personal appearance. The improvement is so universal and so marked as to be always distinctly recognizable, and is much more than can be accounted for by the increase in wages which enables him to dress better.

This improvement is even more marked in girls than in men, for the girls invariably acquire a better color and improve in health. In one case the girl bonus workers formed a society and adopted a badge which they all wore. Only those who could earn their bonus were eligible. This incident is a little thing in itself, but it shows the feeling that comes with mastery of some subject. They know what they can do and are proud of it. This consciousness of efficiency, this knowledge that they have succeeded and can do it again, puts the worker in a very different class from those who go along day after day watching the clock and doing just enough not to get discharged.

The task gives the worker a definite object to strive for, causes a certain amount of mental exhilaration, and invariably increases the keenness of the perceptions.

From our task workers we frequently get instructors and sometimes investigators. From our investigators and instructors we get an ample supply of superintendents and foremen. The foremen and superintendents trained under this system have proved far more successful than any it was possible to hire.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

II. HEAD-RACES, PRESSURE PIPES, AND PENSTOCKS.

This is the second article in Mr. Koester's series; the first installment, published in April, was concerned with the impounding of water supplies and the engineering construction necessary to that end. The purpose is not to instruct the specialist in hydro-electric engineering. It is to provide a clear and concise statement of the fundamentals of established practice in this field for the use of others who may be interested, either as practitioners in other provinces of engineering, as owners or managers of power-using installations that may be electrically operated, as providers or purchasers of machinery for some part of the equipment, or as commercial or financial participants in some development involving the utilization of water power.—THE EDITORS.

WHILE some hydroelectric plants require a dam only, from which the water is conveyed by means of pressure pipes or penstocks to the power house, others require a head race for bringing the water from upstream to a collecting basin, from which the penstocks lead to the turbines in the power house. The head race may be a flume, trench, canal, or tunnel.

Flumes are made either of masonry or planking. The largest use of wooden flumes is in the western States and on the Pacific coast. They are constructed of California fir, redwood, or Oregon pine, and carried on trestle-work or on concrete piers. They are usually of the open type and built on a slope of ½ to 1 foot in 1,000. The planking must be laid so as to break joints, the flumes must be water-tight, and the wetted perimeter must be smooth to allow a velocity of 7 to 8 feet per second. Where flumes run along mountain slopes they should be provided with some means of protection against sliding earth or loose boulders, which may be done either by covering the flume and placing on top at least two feet of earth, which acts as a cushion, or by building on the mountain side of the flume a retaining wall of sufficient height to deflect the boulders across it.

The common form of canal is a trench dug in the soil and the sides sloped, depending upon the firmness of the soil, usually 1 : 1. The velocity chosen depends upon the character of the soil. The table on the following page gives the velocities which are safe and also the mean velocities.

VELOCITY OF WATER IN CHANNELS.

Material of channels.	Safe bottom velocity in feet per second.	Mean velocity in feet per second.
Soft brown earth.........	0.249	0.328
Soft loam................	0.499	0.656
Sand	1.000	1.312
Gravel	1.998	2.625
Pebbles	2.999	3.938
Broken stone, flint.........	4.003	5.570
Conglomerate, soft slate...	4.988	6.564
Stratified rock............	6.006	8.204
Hard rock................	10.009	13.127

The lowest velocity is found in the wetted perimeter, and according to Rankine the different velocities are in the ratio of 2 : 3 : 4 in low-velocity canals, and 3 : 4 : 5 in high velocity canals. The greatest velocity is found in the middle slightly below the surface of the water.

The following figures are selected from a diagram by W. A. Burr in *Engineering News,* Feb. 8, 1894:

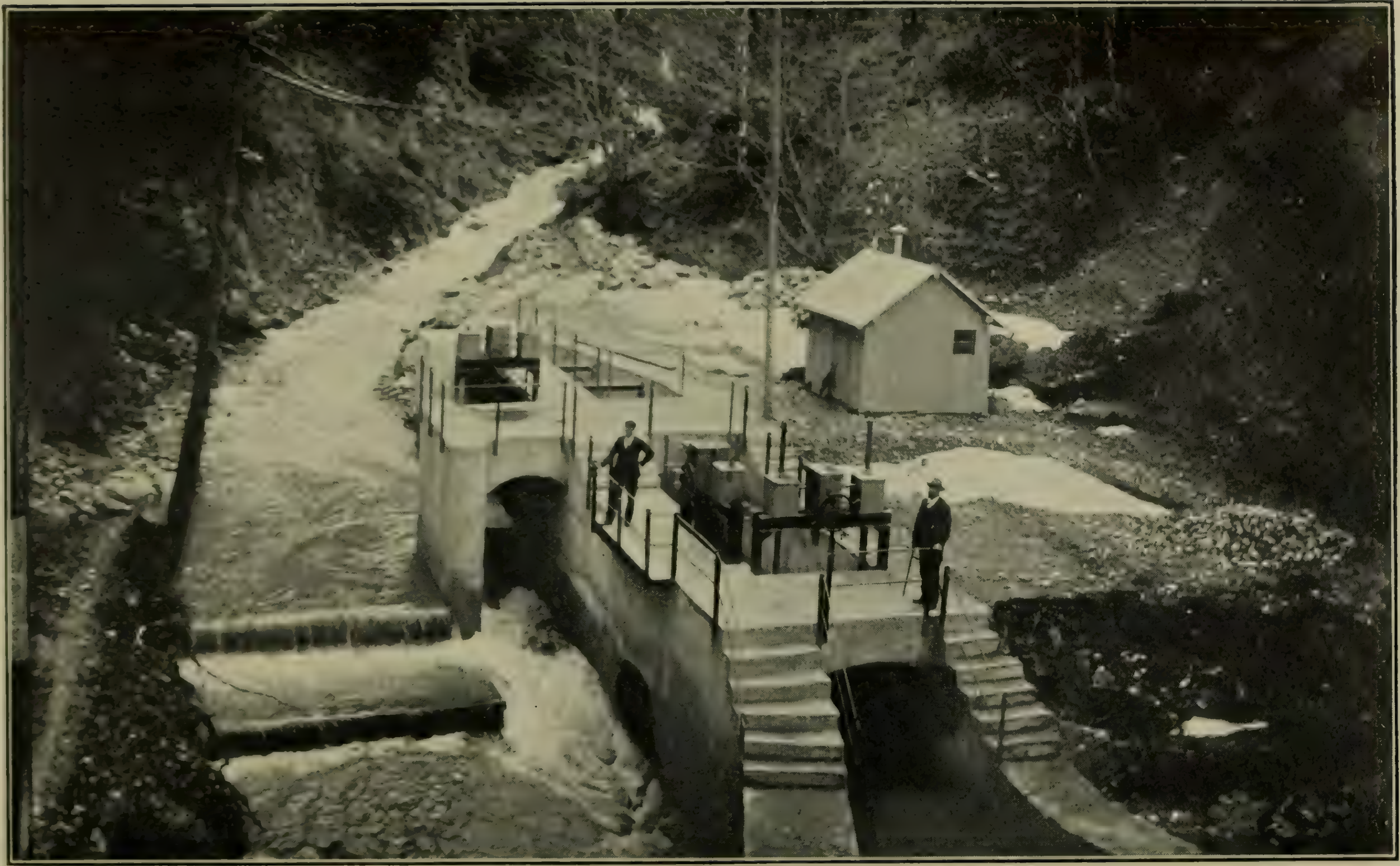
MAXIMUM WATER VELOCITY IN CHANNELS.

Material.	Velocity in feet per second.
Pure sand.................................	1.1
Sandy soil, 15 per cent clay.................	1.2
Sandy loam, 40 per cent clay................	1.8
Loamy soil, 65 per cent clay................	3.0
Clay loam, 85 per cent clay.................	4.8
Agricultural clay, 95 per cent clay...........	6.2
Clay	7.35

The cross-section of a canal, be it trench or flume, should be such that the water will rise to about three-quarters or seven-eighths of the height, but it should never exceed seven-eighths, and should be so proportioned that the depth of the water is about half of the width.

For conveying the water through tunnels non-pressure or pressure tunnels are used, the former being the most common. A non-pressure tunnel is only partly filled, while a pressure tunnel of course is completely filled. The average slope for either is 1 to 2 feet in 1,000 and the tunnel must be of such size that the water velocity will be 7 to 8 feet per second. The cross-section of these tunnels may be rectangular with an arched roof, or semi-egg-shaped. Where they run through loose soil they must be lined with concrete or brick, the thickness of which depends, of course, upon the character of the soil.

In late years numerous installations of the pressure type of tunnels have been made. These must be properly lined and made water-tight as far as possible. Where these pressure tunnels are long, vent pipes

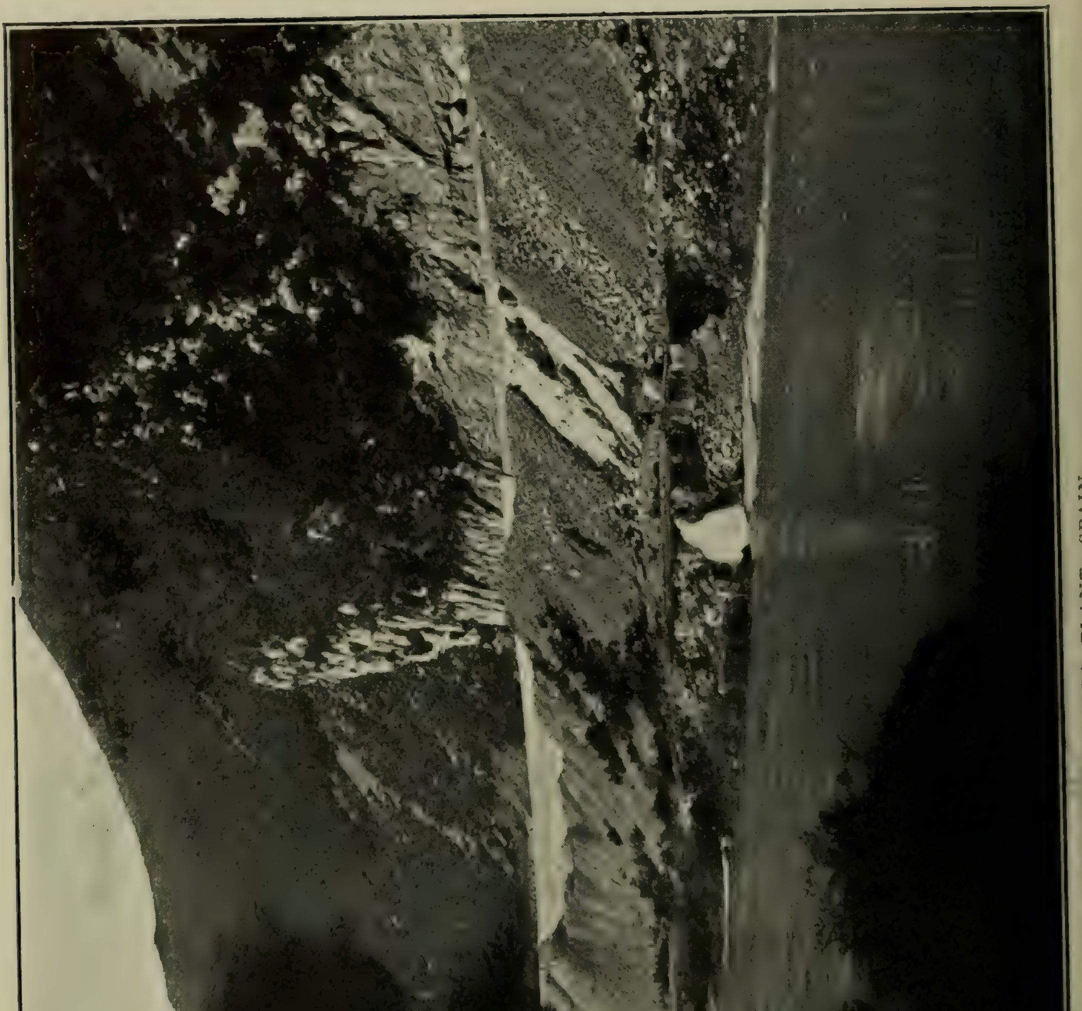


INTAKE TO HEAD-RACE OF A SMALL PLANT AT CHUR, SWITZERLAND.

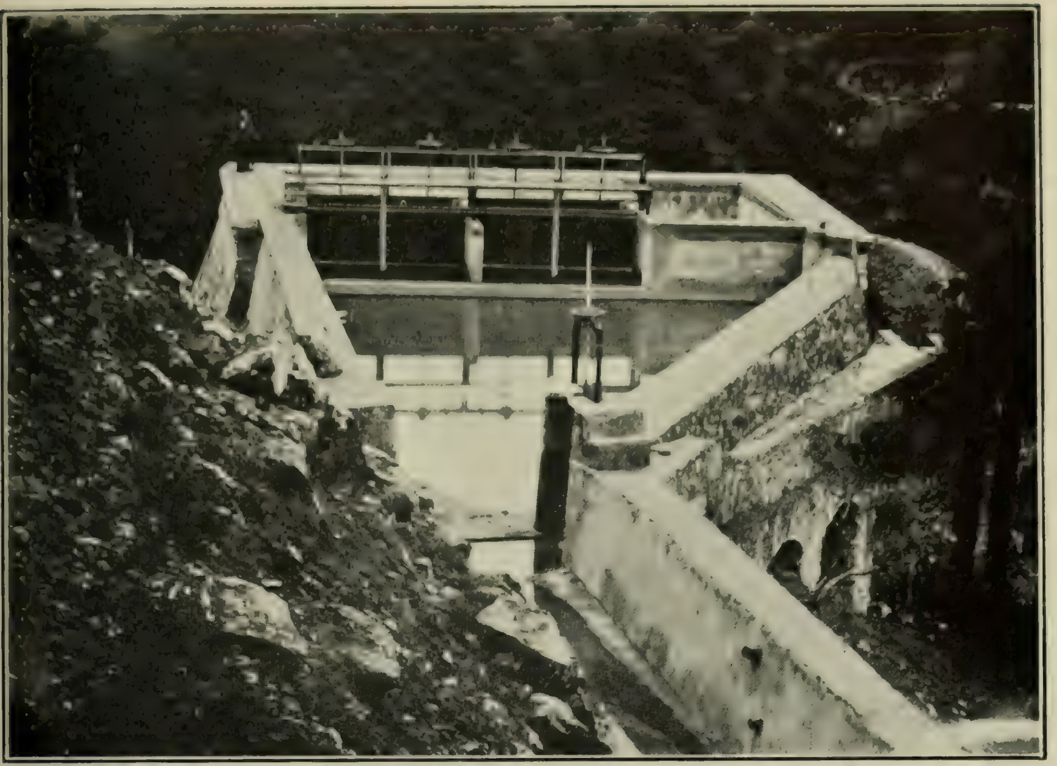
must be provided so no air may enter the penstocks which, necessarily, must be connected to the tunnels without any intermediate collecting basin. A notable example, making use of a vertical shaft as an equalizing chamber, is found in the Urfttalsperre plant, Germany, which operates under a head varying from 230 to 360 feet. The shaft is located at the junction of the pressure tunnel (8,850 feet long) and the penstocks. It is sunk through the mountain and its upper end, which is above the high-water level of the reservoir, is enlarged to prevent overflow during sudden fluctuations, so that no water is wasted when the turbines are suddenly shut down.

DAM AND SLUICE GATES OF HEAD-RACE IN A SMALL TYROLESE PLANT.

The utilization of the water of mountain lakes may be accomplished either by tapping them at the bottom or by syphoning. The former method is very troublesome, as sheet piling must be driven and the water pumped out at the tunnel junction, and where soft soil is encountered it is particularly troublesome. In Switzerland, where many mountain lakes are found, the syphoning system has been introduced. This consists in sinking a vertical shaft a short distance from the shore of the lake; the water is syphoned from the lake to the shaft, to which latter the head race is connected. Such an installation will be found at Kubel and at Lake Poschiavo in connection with the Brusio power



HEAD-RACE OF THE PUENTALARRA PLANT, SPAIN.



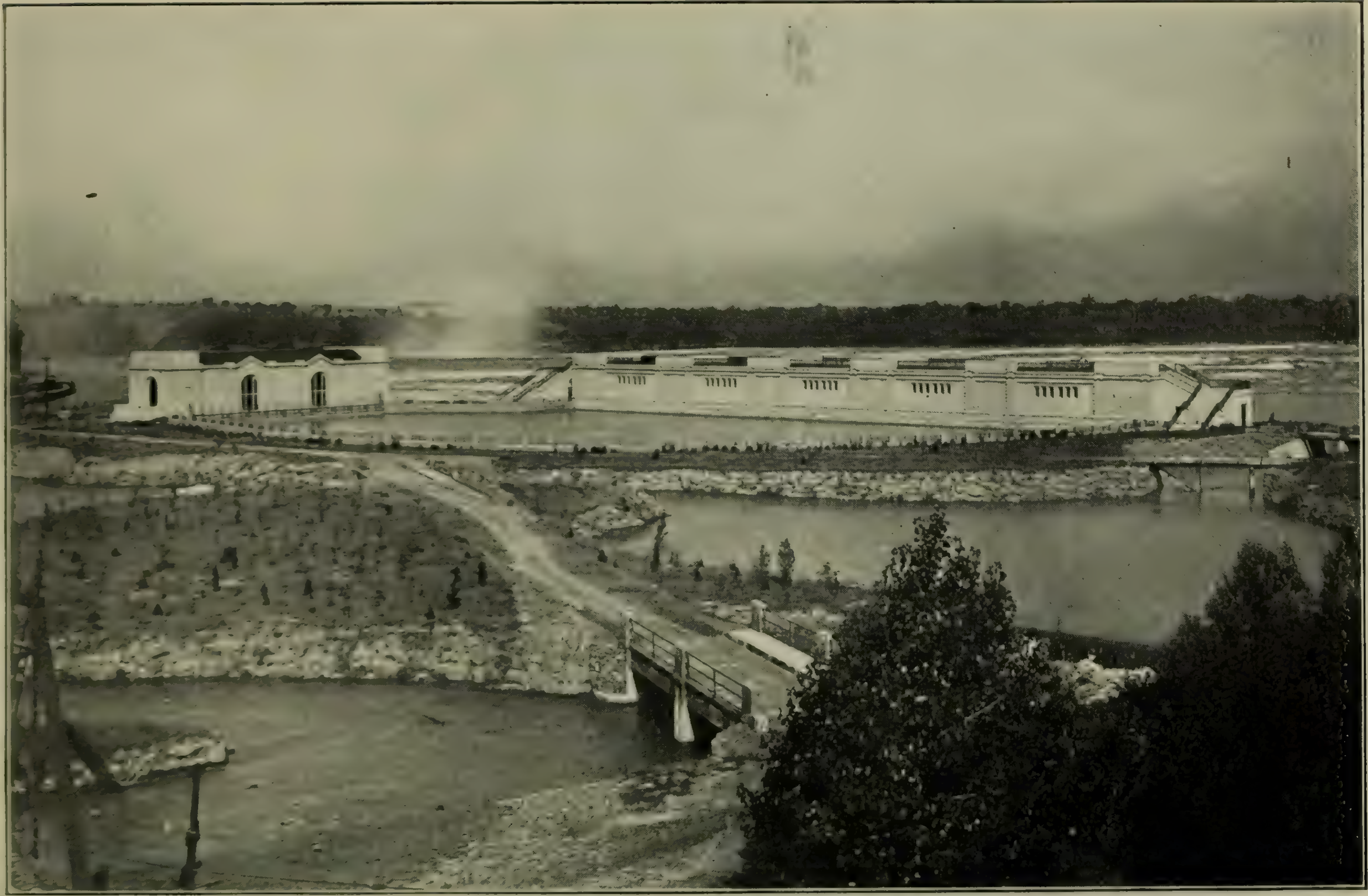
COLLECTING BASIN OF EL CORCHARDO HYDROELECTRIC PLANT, SPAIN.

plant. The shaft is sunk about 75 feet from the water's edge and carried 7.5 feet below the low-water level of the lake. The syphon tube leads from here into the lake and is 6.5 feet in diameter and 270 feet long, partly resting on trestle work. The suction leg is 26 feet long, provided with a screen and butterfly valve, while the discharge leg is 27.7 feet long, the bottom end of it being provided with a disc valve for regulating the flow of water.

The syphon is started by means of an air pump connected to the horizontal leg of the tube at its highest point, the slope of this leg being 5 feet in 1,000. It may also be started by the centrifugal pump which is installed for cleaning the intake screens.

The system must not be confused with the so-called "invert syphon" system, which is a misnomer, being nothing more than a pressure system. It must furthermore be remarked that this Swiss system is by no means a small affair as it syphons the supply of water for twelve 3,500-kilowatt turbines, installed in the largest hydroelectric plant on the Continent of Europe.

In other than pressure tunnels the junction between head race and penstocks must be made by introducing a collecting basin of sufficient size to allow for slight fluctuations of flow. The area of the head race may be increased at its junction with the collecting basin so that the



HEADWORKS AT DUFFERIN ISLAND, ONTARIO POWER COMPANY, NIAGARA FALLS.
Screen house and gate house at intake.

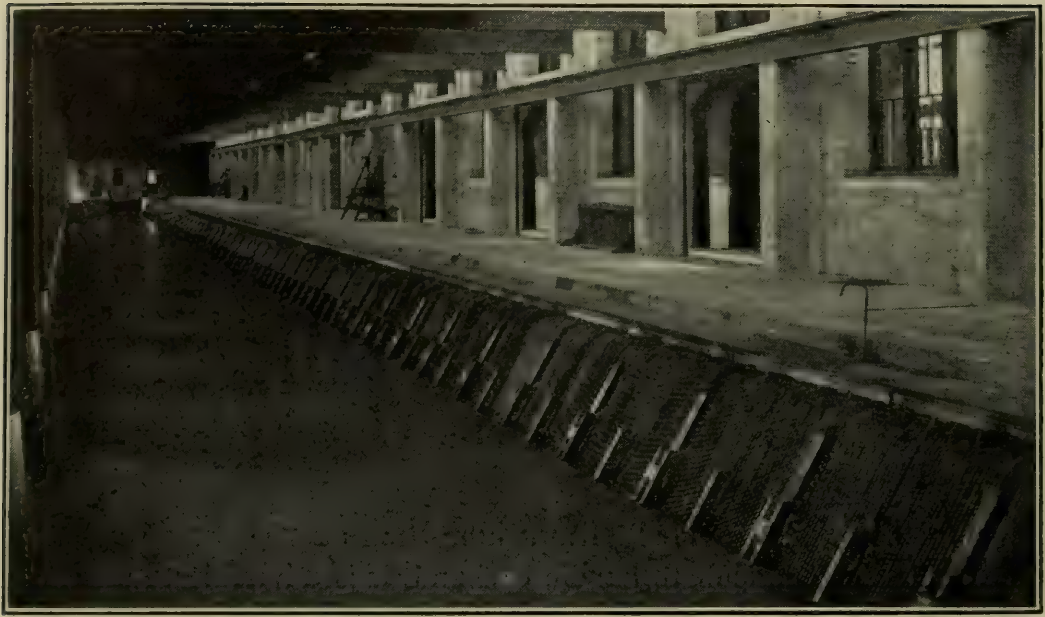
latter itself need not be too large. Under ordinary conditions the size of the collecting basin should be such as to reduce the velocity of the water to 1 foot per second, which will allow all heavy foreign material to settle, thus preventing it from entering the penstocks. It is, however, considered good practice to provide the penstocks with screens nevertheless. These screens are preferably set on a skew, so that the foreign matter may be forced to one side of the collecting basin where it may flow off through spillway sand or gravel traps.

All penstocks should be provided with cut-off valves at the collecting basin. They are usually of the gate type, butterfly valves being seldom used. The smaller sizes are hand-operated, the larger ones mechanical or motor-operated.

To protect the operating mechanism of the gates and screens a housing should be provided. In medium-head plants where the gates and screens are difficult to handle by hand, it is advisable to install a hand-operated travelling crane.

Screens are generally made of 2-inch by ⅜-inch bars, spaced ⅝ inch to 1 inch apart. They are preferably made in sections, unless very small, so that they may be easy to operate. In many instances duplicate sets are used, the mechanism being such that when one section is raised for cleaning, the other is lowered into position. Where heavy floating material or anchor ice is encountered racks should be

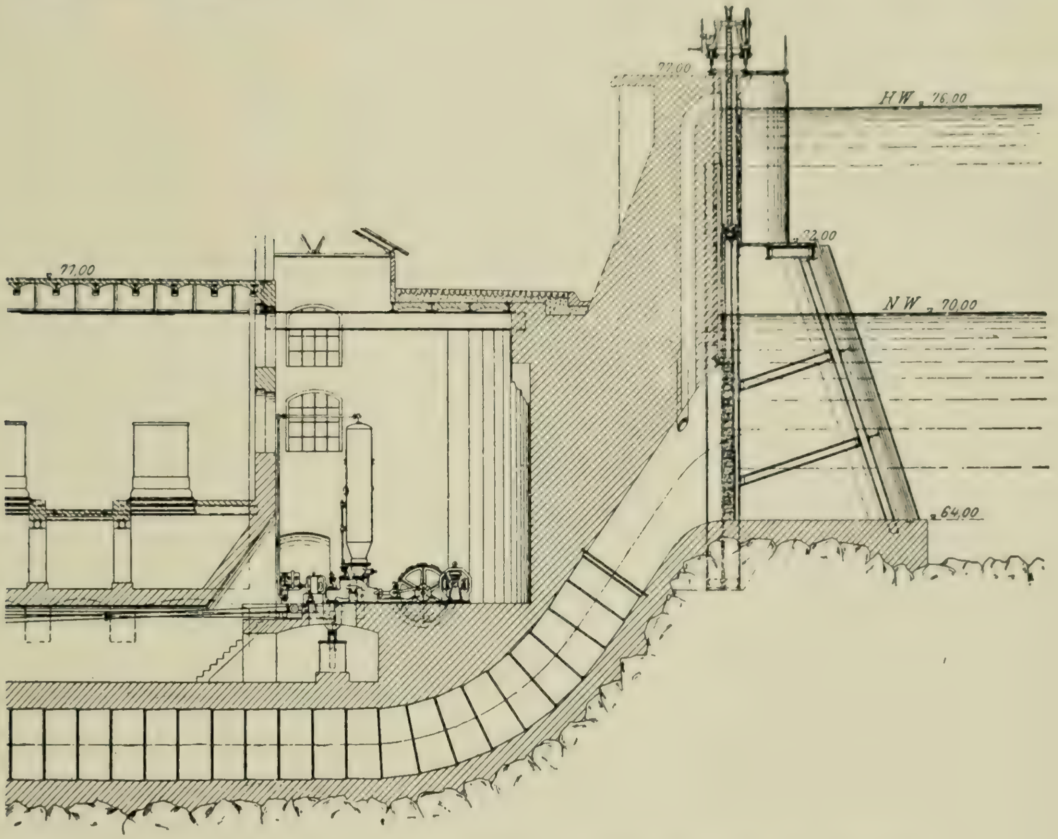
SPILLWAY HEADGATES AND CANAL OVERFLOW, GREAT FALLS PLANT.



SCREEN HOUSE, PLANT NO. 2, NIAGARA FALLS POWER COMPANY

installed either at the inlet to the head race or at forebay in low-head plants. Racks are frequently made of round bars or tubes; this, however, is not good practice, as foreign material will gather more easily on round bars than on flat ones. Furthermore, it is more troublesome to clean racks made up of round bars for the reason that the wedge-action of the floating material is greater with these than with flat bars. The spaces between bars should not be less than ½ inch and should never exceed 4 inches. When the racks must withstand heavy shocks from floating or anchor ice, or logs, etc., the bars should preferably be made of I beams. Such construction is seen in the screen installations illustrated on pages 185 and 187. It acts simultaneously as a deflector for throwing all floating material over the spillway. It will be noticed that the rack, as it is of heavy construction and built in sections, is raised, in sections, by means of a windlass travelling on a bridge from which the sections are supported. By means of these racks the head of water may also be regulated as the area may be reduced or enlarged according to the position given to the rack. Directly behind this rough rack and deflector is a sand trap and a fine screen, so that the collecting basin is well protected.

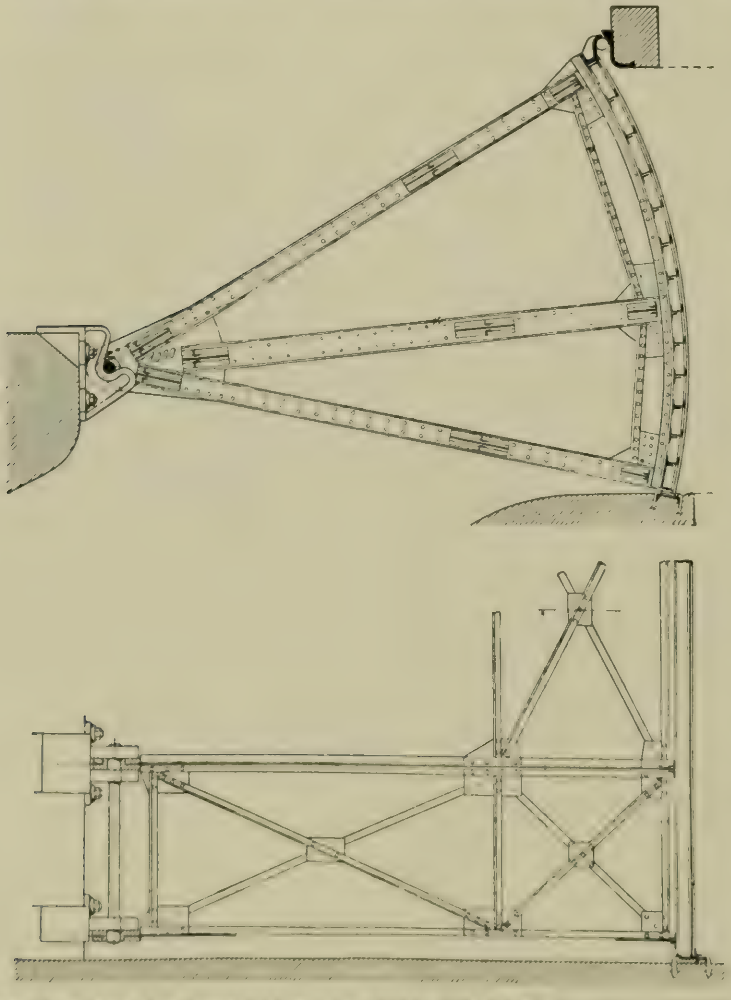
For controlling the water-supply to the head race vertical moving sluice gates are provided which, up to 100 square feet in size, are made of wood, while those of larger size are of structural steel. If conditions favor the use of large wooden sluice gates these must be made in sections, as the gates would otherwise be too bulky. The large gates should be provided with rollers, while the smaller wooden sluice gates may run on iron or brass strips, the latter being preferable. When there are a great number of gates of large size they are preferably operated by motors, and one portable motor may be used. Provision, however, should be made also for operating them by hand, and to facilitate this counterweights should be applied. Where quick action is desirable, air or hydraulic pressure cylinders may be used for operating heavy gates.



SCREENS, GATE AND PENSTOCK, KYKKELSUND PLANT, NORWAY.

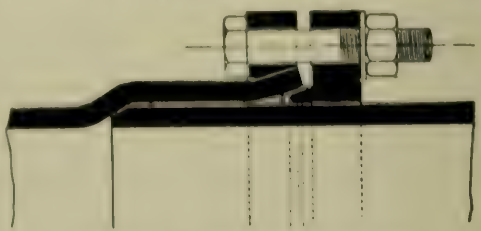
Drum gates are also used in connection with low-head plants, the construction forming a segment of a drum as seen on page 186. Such gates have been installed in connection with the Chèvres plant in France, being located in the turbine chambers, and as the pressure is against the drum, with a tendency to push it away from the seat, care must be taken to prevent excessive leakage. This may be accomplished by a rope or steel cable at the top edge as shown, and by wooden blocks at the bottom, upon which the gate rests.

Gates of similar design are frequently found in the western States for increasing the head at a dam, acting as a flash-board or movable dam.



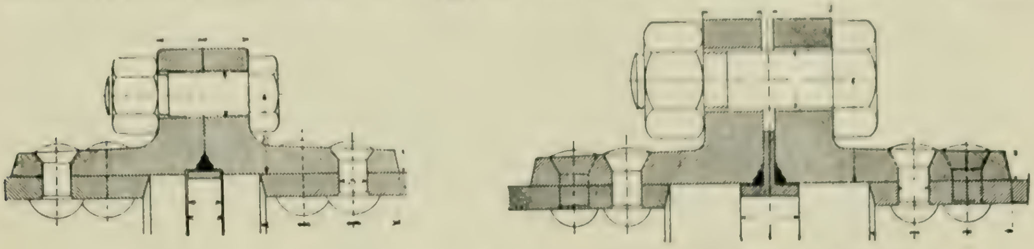
DRUM GATE AS INSTALLED AT THE CHEVRES PLANT, FRANCE.

Penstocks.—Penstocks are made either of steel-plates, riveted or welded, of wooden staves, or of reinforced concrete. The riveted steel plates are much used. However, for exceptionally high heads, and to reduce the friction due to the large number of rivets necessary, welded-tube sections, made so as to telescope, have been much used in Europe and also, of late, in America; the penstocks installed for the Western Power Company and for the Necaxa plant in Mexico being partly of this type. For the last named plant there are six 30-inch penstocks, each having a length of 2,460 feet. The lower sections are subjected to a static head of 1,200 to 1,300 feet and the thickness of the shell varies from 0.4 inch to 0.95 inch. They were shipped from Germany in sections 29.5 feet in length. As the penstocks in high-head plants are of larger diameter for the upper than for the lower sections, and as all sections are provided with loose flanges, they may be nested for shipping, thus securing another great advantage.



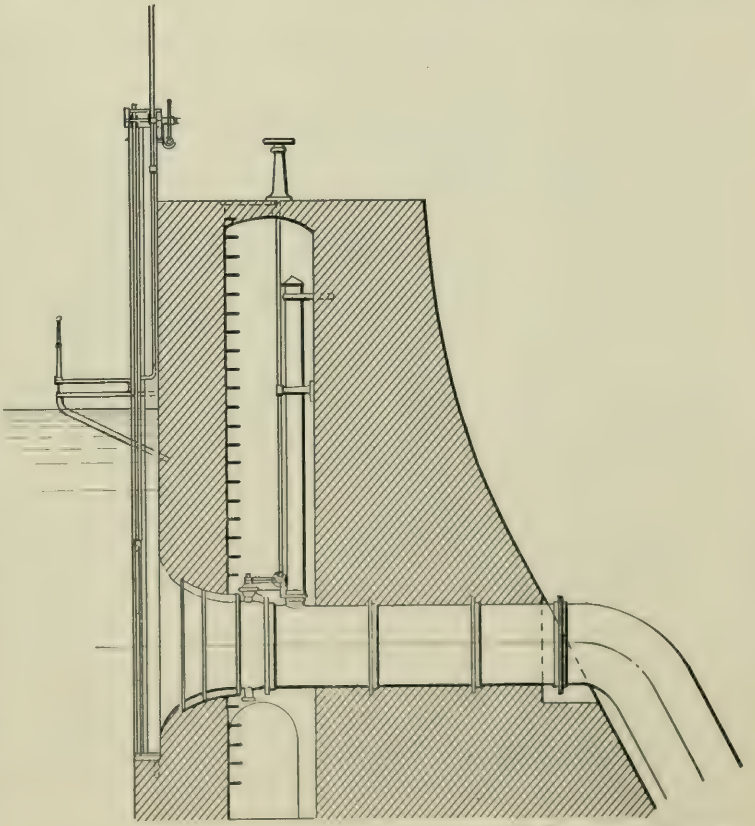
FERRUM SLIP-JOINT FLANGE.

The flanges of this type of penstock are as shown on this page. It will be seen that one end of the tube is enlarged to receive the straight end of the next section, thus doing away with the otherwise necessary expansion joints, as a slip joint is provided. One of the flanges is provided with a beveled lip which fits into a corresponding recess of the large end of the pipe and forces therein a tapered soft-metal ring, thus making a tight joint. This type of penstock and flange is also used in the Loch Leven plant, Scotland, where six are installed, each having a length of 6,230 feet. The lower sections are subjected to a pressure of 425 pounds per square inch. They are 40 inches in diameter and the thickness of shell varies from ⅜ to ⅞ inch. These penstocks are laid in sections 19.7 feet in length and held in place by concrete anchor blocks about 175 feet apart.



TYPES OF PENSTOCK FLANGES USED IN RECENT LEWIS PRACTICE.

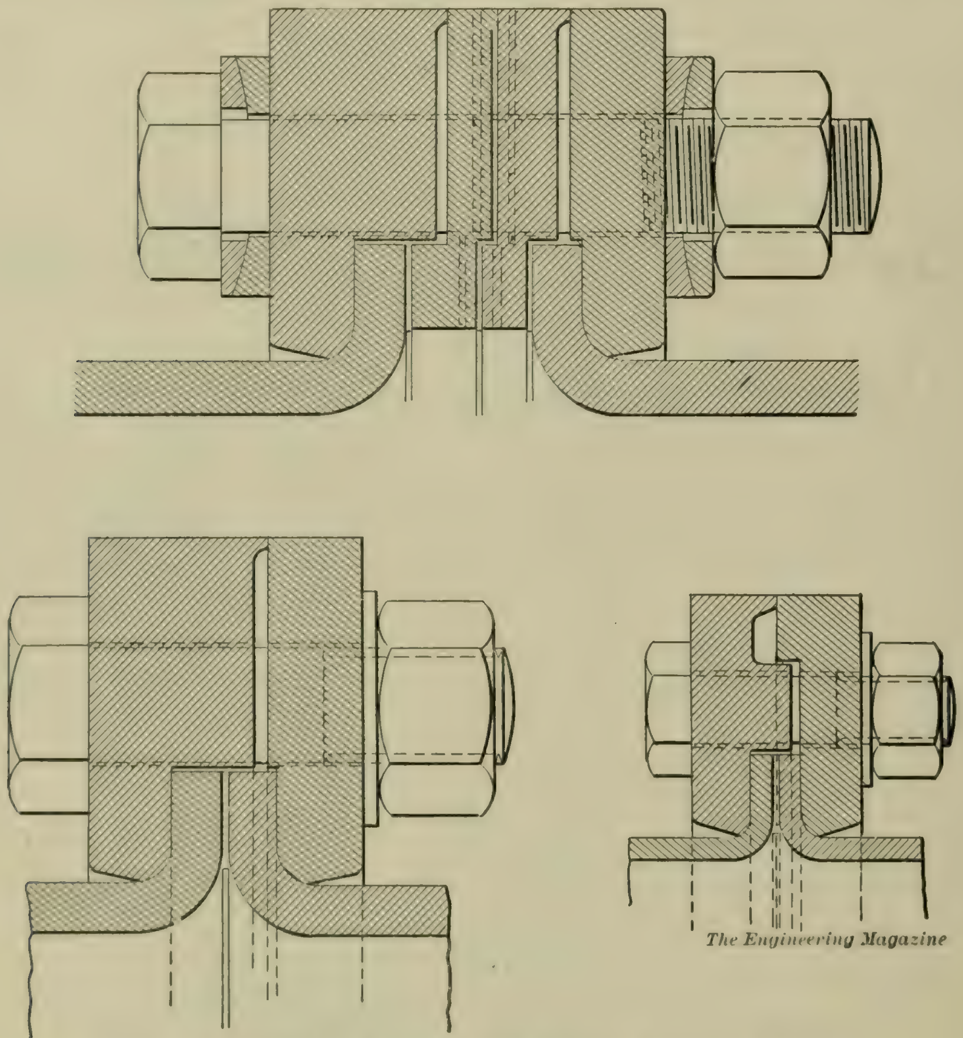
On page 188 are shown three different designs of flanges as used in the Necaxa penstocks. It will be noticed that the flanges have a lever action on the flared ends of the penstocks. Where ordinary riveted steel penstocks are used, and so long as they are not laid underground, expansion joints must be provided; these are preferably of the stuffing-box type. Where slip-joints are provided at intervals the anchors of the pipe must be arranged accordingly, so that the expansion between two ancher-blocks is properly taken up. The



The Engineering Magazine

TYPICAL ARRANGEMENT OF DOUBLE SCREENS AND VENT FOR PENSTOCK INLET.

penstocks should rest on saddles, and to allow for creeping these should be of cast-iron mounted on masonry blocks.



The Engineering Magazine

TYPES OF PENSTOCK FLANGES FOR NECAXA PLANT, MEXICO.

Wooden penstocks are practically installed for heads not exceeding 300 feet, and for higher heads the lower sections should be made of steel. Some of the advantages of these over metal or concrete penstocks are their smoothness, giving a greater carrying capacity, ranging from 10 to 20 per cent over the others. They are, furthermore, cheaper in first cost and do not deteriorate as rapidly as those of metal, nor does frost affect them. In some cases it might be extremely difficult to transport heavy steel penstocks over a country where there are no roads. The staves and bands for wooden penstocks may be easily transported by mules through woods or mountainous country.

PENSTOCK BRIDGE, CHUR PLANT, SWITZERLAND.

A good example of wooden-stave penstock installation is that in connection with the Bishop Creek power plant. One pipe is 42 inches

EIGHT-FOOT WOODEN-STAVE PENSTOCK, PENDLETON ROLLER MILL CO., PENDLETON, OREGON.

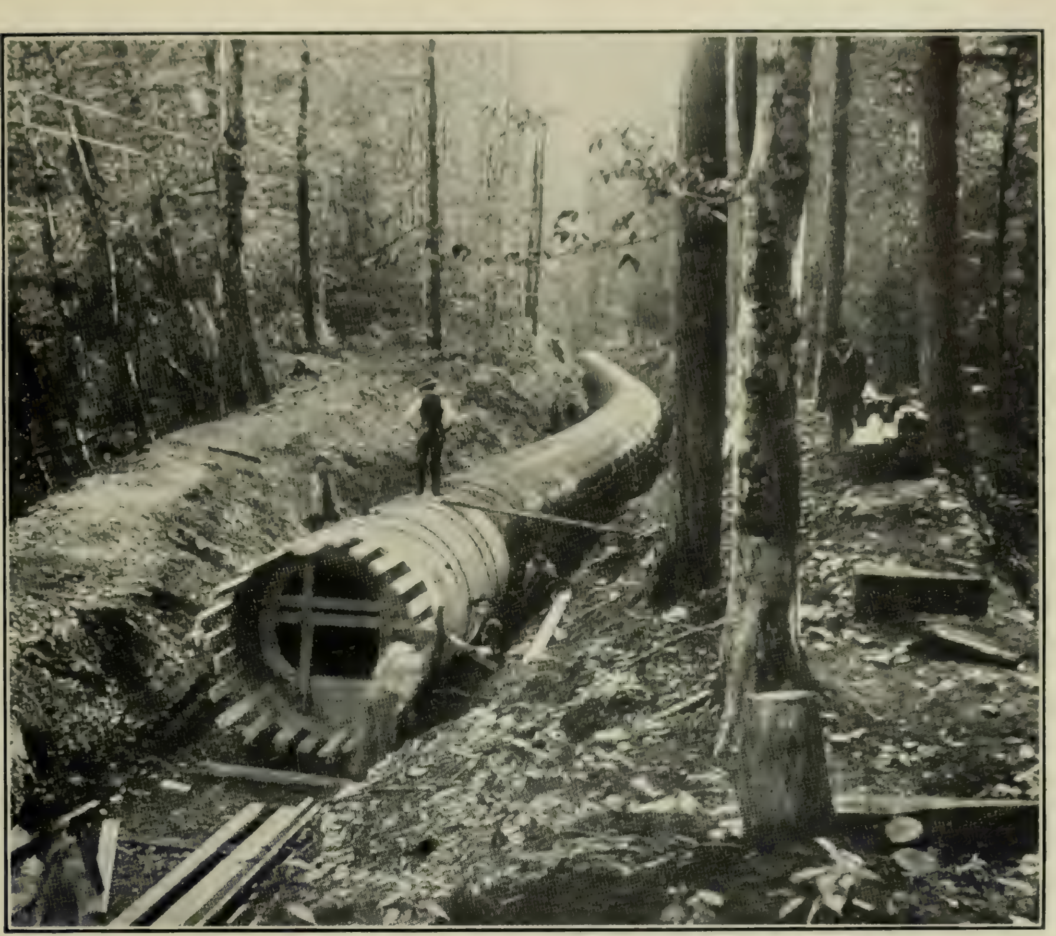
in diameter and 6,700 feet long and another is 30 inches in diameter and 2,150 feet long. The 42-inch penstock is made up of 25 staves and the 30-inch of 19 staves, milled from 2 by 6 inch stock, which is red fir from southern Oregon. The bands are made of mild steel ½ inch in diameter, with ends upset to ⅝ inch in diameter. They were shipped straight and bent to form on the spot. The lugs are of cast-iron, of a form to allow the ends of the bands to pass each other, nuts being used on both ends. The spacing of the bands is 6 inches for the 42-inch pipe. The ends of the staves are slotted and a 3/16 by 1/2 inch compressed paper dowel is inserted. When wet these dowels swell and prove very efficient for closing up leaks.

Large radius bends are readily made, but cast-iron or rivetted steel bends are inserted for bends of small radius. Where small pipes are branched from the side of the main penstock cast-iron saddles are provided and fastened by bands similar to those described.

Reinforced-concrete penstocks have not been used to a great extent, though for low-heads they have been in use in France for a number of years. They are made by the use of inner and outer forms, the concrete being used rather wet and tamped. Rods are usually used for reinforcement, although expanded metal or similar material may be used.

A new process, the Siegwart system, has been developed in Switzerland whereby penstocks of reinforced concrete can be made by machinery, capable of carrying pressures up to 300 pounds per square inch and higher. Being manufactured by automatic machinery of very compact design these penstocks can be rapidly made in the field, in sections the length of which depends upon the size of the machine used. The ends are fitted with special joints which, after the penstock is in place, are filled with asphalt. An external band is slipped over the joint and sealed by the asphalt. After coming from the machine the sections are coated inside with a layer of asphalt. This treatment renders the penstock absolutely water-tight and in addition reduces skin friction.

The present practice is to install a number of penstocks rather than one large one. They should be arranged side by side and the bed selected for them should be made as even as possible. If the natural soil is unsafe to carry the penstocks it must be reinforced to avoid any possibility of land slides, which in some cases have put penstocks out of commission. When a number of penstocks are installed it is well to build, as a part of the penstock bed, a permanent road by which means sections of the penstocks are also conveyed to



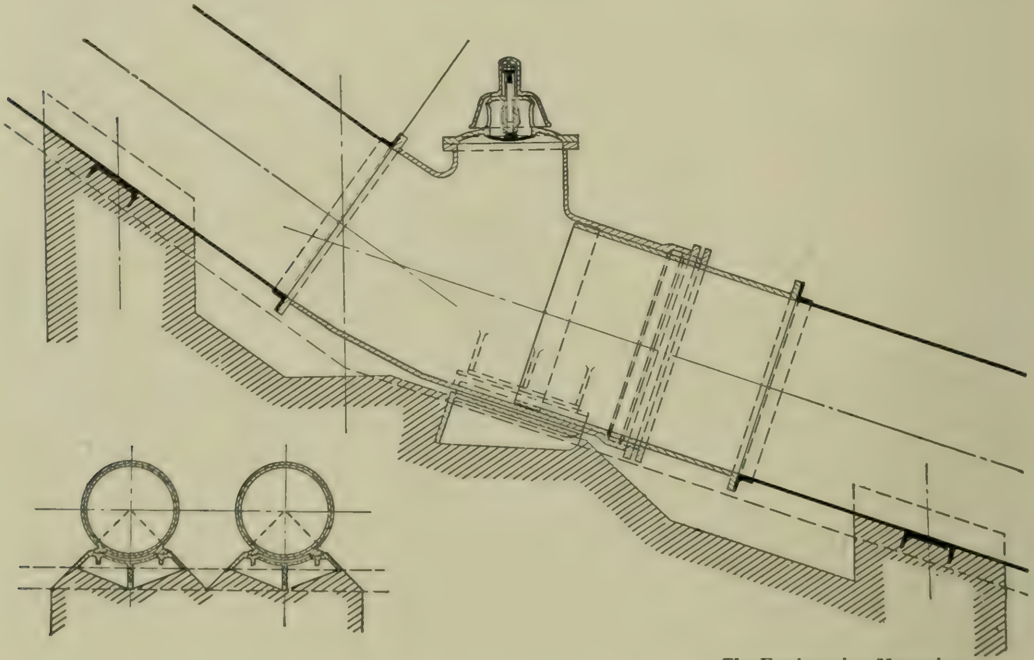
A 7-FOOT WOODEN-STAVE PENSTOCK, 3700 FEET LONG, UTICA GAS & ELECTRIC COMPANY, TRENTON FALLS, N. Y.

their place. Such practice is frequently adhered to in Switzerland and Italy, the plant at Brusio being a good example. Here a motor-operated cable road is installed on the mountain slope beside the penstocks. Now that the penstocks are in place this is used for inspection and repair purposes.

Where multiple penstocks are laid they must be inter-connected, preferably near the power house, and properly equipped with valves so that, in case of emergency, the water of any penstock may supply any other turbine.

The penstock run must be the most direct that can be had and planned so as to avoid short turns, to minimize the friction. To shorten the run they may be carried through tunnels or across valleys on trestles or piers.

The size of the penstock depends, of course, upon the amount of water to be supplied and the head available; conditions being equal, the velocity of the water under high head must be greater than that under low head. However, plants have been installed in contradiction to this theory; for instance, the horizontal section of the 18-foot penstock of the Ontario Power Company's plant, under a head of 20 feet, has a velocity of 15 feet per second, while the velocity in a 30-inch penstock of the Necaxa plant, under a head of 1,300 feet, is 15 feet per second under a normal full load, while under an extremely high load it is 18 feet per second.


The Engineering Magazine

VACUUM RELIEF VALVE PLACED NEAR LONG VERTICAL SECTION OF PENSTOCK, VAUDOISE PLANT AT LAKE ORBE.

As an average it may be said that penstocks from 1 to 2 feet in diameter have a velocity of from 20 to 30 feet per second, while under a head of 1,000 feet or more and for penstocks of 2 to 3 feet in diameter the velocity chosen should be 10 to 16 feet per second.

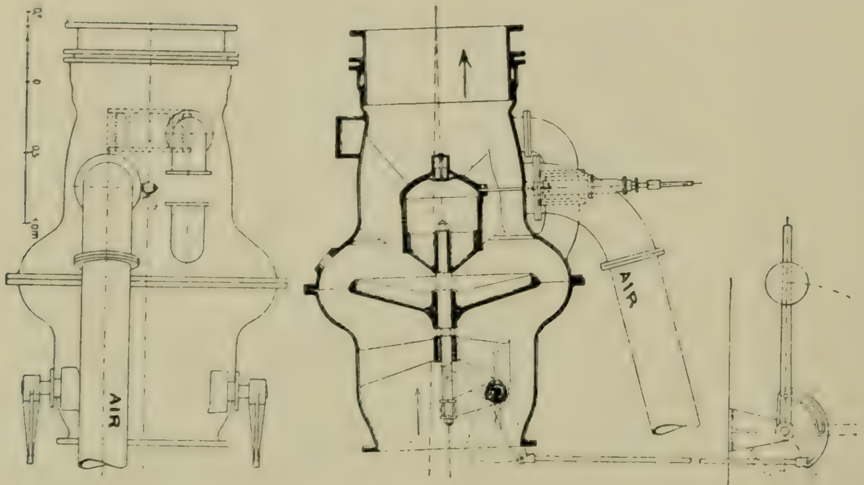
The losses due to friction depend upon the head and the diameter of the penstocks, as well as upon the condition of the inside surface of the pipe, whether rusty, full of silt, dents in the pipe, etc. In brief, the law may be stated as follows: 1, for equal velocities the friction loss is proportional to the length of the penstock; 2, friction increases very nearly as the square of the velocity; 3, for equal lengths of penstocks, the friction decreases with the increase in diameter; 4, the rougher the interior surface the greater the friction. The accompanying table is an abstract from table of the Pelton Water Wheel Company. It gives the loss of head by friction for each 100 feet of penstock at different diameter, under different discharges, in cubic feet at velocities of from 2 to 7 feet per second.

LOSS OF HEAD BY FRICTION IN PENSTOCKS.

Inside diameter of pipe in inches.

	12		13		14		15		16		18	
Vel. in feet per sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	.198	94	.183	110	.169	128	.158	147	.147	167	.132	212
3.0	.407	141	.375	166	.349	192	.325	221	.306	251	.271	318
4.0	.685	188	.632	221	.587	256	.548	294	.513	335	.456	424
5.0	1.03	235	.949	276	.881	321	.822	368	.770	419	.685	550
6.0	1.43	283	1.325	332	1.229	385	1.148	442	1.076	502	.957	636
7.0	1.91	330	1.75	387	1.630	449	1.520	515	1.430	586	1.270	742
	20		22		24		26		28		30	
2.0	.119	262	.108	316	.098	377	.091	442	.084	513	.079	589
3.0	.234	393	.222	475	.204	565	.188	663	.174	770	.163	883
4.0	.410	523	.373	633	.342	754	.315	885	.293	1026	.273	1178
5.0	.617	654	.561	792	.513	942	.474	1106	.440	1283	.411	1472
6.0	.861	785	.782	950	.717	1131	.662	1327	.615	1539	.574	1767
7.0	1.143	916	1.040	1109	.953	1319	.879	1548	.817	1796	.762	2061
	33		36		39		42		45		48	
2.0	.073	712	.066	848	.061	995	.057	1155	.053	1325	.050	1508
3.0	.148	1070	.135	1273	.125	1442	.117	1730	.109	1987	.102	2260
4.0	.248	1425	.228	1697	.210	1990	.195	2310	.182	2650	.171	3016
5.0	.374	1780	.342	2121	.316	2490	.294	2885	.273	3310	.256	3770
6.0	.520	2140	.479	2545	.441	2986	.408	3461	.382	3970	.358	4524
7.0	.693	2495	.636	2968	.586	3484	.545	4030	.509	4638	.476	5277

For protecting the penstocks against surges, vacuum, frost, etc., they must be provided with relief devices. The upper end of the penstock should be fitted with a vent pipe which must extend above the high-water level of the collecting basin or reservoir. This vent pipe under all circumstances must be protected against freezing up; otherwise it may fail of its object. Where, after a long horizontal run, a drop of any great extent occurs, a vacuum relief valve must be inserted near the upper end of the drop leg, for the purpose of letting in air to prevent the creation of a vacuum which might form when the turbine gate is open, because the velocity in the vertical section is greater than in the long horizontal line. The lower ends of the penstock must be provided with relief valves or blow-out plates, or standpipes, so that in case of a sudden shut-down of the turbines surges in the penstock are eliminated. Standpipes are usually connected at the end of the penstocks and must extend vertically several feet above the water level in the collecting basin. Standpipes are usually wasteful, as they may overflow in the event of a sudden increase of pressure. Another method is the provision, at the lower end of the penstock, of an air-cushion which is nothing more than an enclosed chamber; this



AUTOMATIC LOW-WATER DEVICE FOR PROTECTING PENSTOCK.

must be kept absolutely air-tight or the device will be rendered useless. In connection with the Jajce plant in Bosnia, in 1899, I experienced this difficulty, and to remedy it an air pump had to be installed to maintain the air-cushion.

In exceptionally cold regions penstocks must be protected against freezing. They may be imbedded in the ground below the frost line, or protected by wooden boxes. In the former case the trench must be left open at least several months after operation has commenced to ascertain whether additional caulking is necessary. All steel penstocks must be coated with asphalt, both inside and out.

THE FUEL-BRIQUETTING INDUSTRY.

By Charles L. Wright.

FUEL DRIERS AND BRIQUETTING MACHINES.

Published with the Approval of the Director of the U. S. Geological Survey.

Mr. Wright is Assistant Engineer, U. S. Geological Survey, in charge of the fuel-briquetting section. He had charge of the chemical and physical tests of briquets and binders at the St. Louis Fuel-Testing Station, superintended the installation of the Government briquetting plant at Norfolk, and later succeeded to charge of the briquetting investigations and installed the briquet plant at Pittsburg, Pa. His articles are prepared under the auspices of the U. S. Geological Survey, as a concise and comprehensive review of the "State of the Art." The first section took up plant, materials and processes; the second part is descriptive and illustrative of equipment and machinery for briquetting, concluding with a discussion of the properties of briquetted fuel, and some statistics of production.—THE EDITORS.

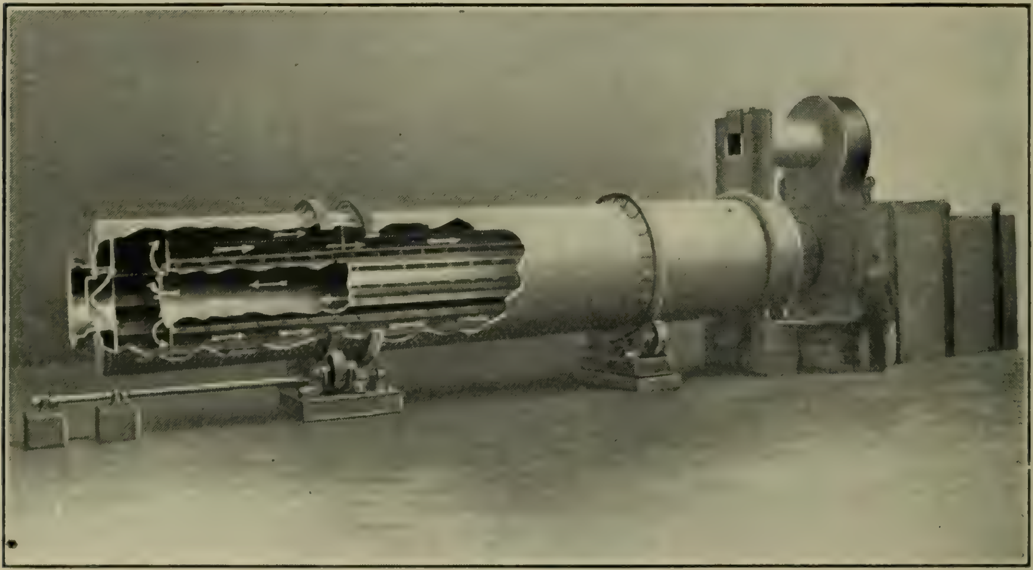
SOME fuels, but more especially lignites and peat, require drying before briquetting. Lignites fresh from the mines in Germany contain as high as 60 per cent of moisture, and sample of American lignites investigated by the U. S. Geological Survey have contained as high as 42 per cent of moisture. Before briquetting this fuel it must be dried considerably so as to contain from 5 to 15 per cent moisture in the briquets. If dried too much it will not briquet. Therefore, to make briquets successfully from lignites requires close control of the drying, and the amount of moisture is the most important factor in briquetting this fuel.

In Germany there are two general types of driers in use in briquetting plants.

One of them, the plate type, consists of a series of circular steam-heated plates arranged one above the other, over which plates the material is moved by scrapers from the center toward the outer edges of one plate, then drops through holes onto the plate below, is scraped from the outer rim toward the center of this plate, then drops through holes onto the next lower plate, and so on through the drier.

On account of the large number of moving parts in the plate drier and their liability to get out of order, this type of drier is gradually being superseded by another type of drier, known as the Schulz drier. This Schulz drier resembles a multitubular boiler supported on bearings at each end, in an inclined position, so that by revolving the drum, the material will move through the tubes by gravity. These driers are 21 to 26 feet long and 7 to 11½ feet in diameter, and have 240 to 364 drying tubes 3¾ inches in diameter, so they have 4,640 to 8,180 square feet of heating surface and will dry in 24 hours from 45 to over 70 tons of wet lignite.

Other types of driers are more commonly used for drying materials in the United States, such as the long, hollow cylindrical driers placed in an inclined position, and heated by direct heat while revolving, the gas passing through the cylinder in some cases.



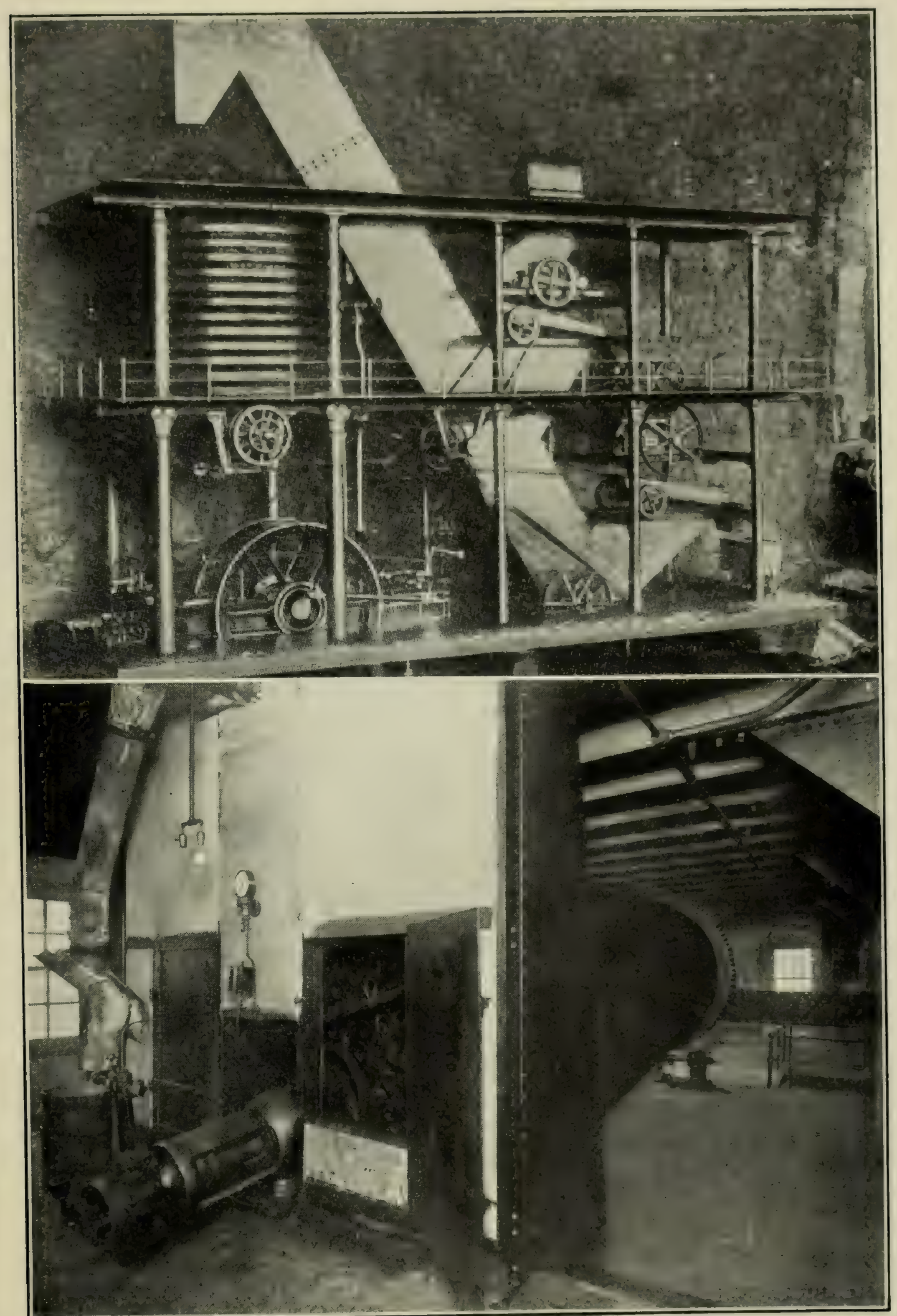
THE RUGGLES-COLES ROTARY DRIER.
Ruggles-Coles Engineering Co., N. Y.

For drying and heating bituminous or anthracite coal for briquetting, another type of drier known as the Bietrix furnace is used in France. It consists of a circular brick chamber in which is revolved a circular horizontal table. Direct heat is passed over this table from a firebox at the side. Scrapers move the coal, while drying, from the center to the outer edge of the table, where it is discharged through openings in the casing. This type of drier is said to be continuous and highly efficient in action.

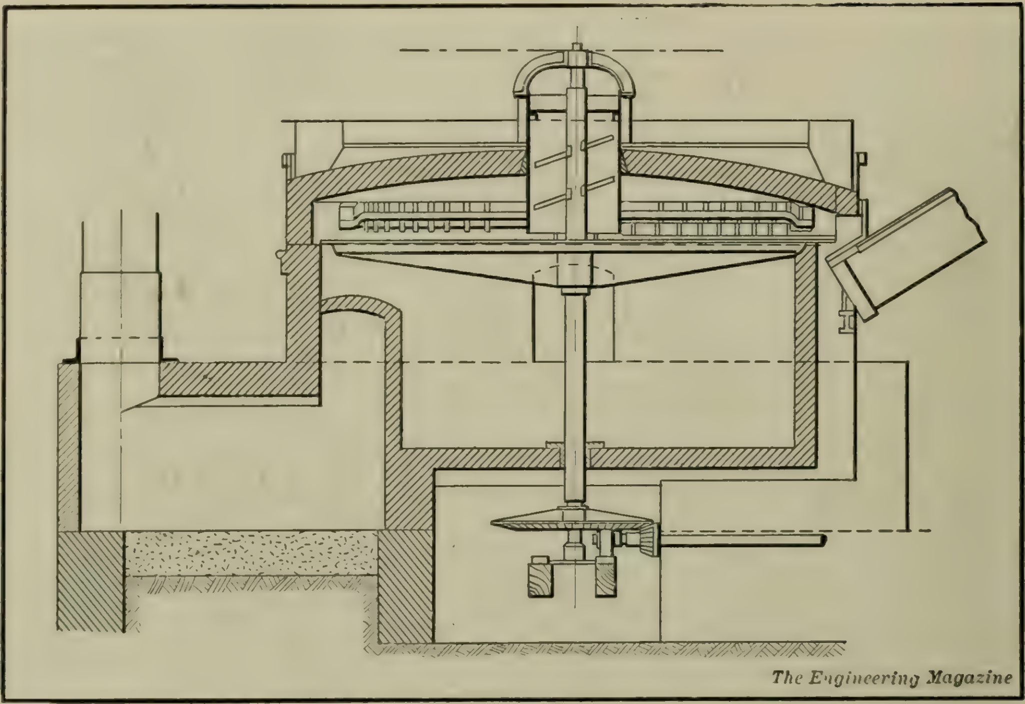
Classes and Characteristics of Presses Used for Fuel Briquetting.

The presses used for briquetting fuel are of three general classes:

Class I. Open-mold machines.
Class II. Closed-mold machines.
Class III. Tangential or rotary machines.



ABOVE, MODEL OF A GERMAN LIGNITE BRIQUETTING PLANT EQUIPPED WITH A PLATE DRIER. BELOW, SCHULZ REVOLVING TUBULAR DRIER.



BIETRIX DRYING AND HEATING FURNACE.

The space allotted to this paper allows of only a brief discussion of the various types of presses.

Class I. Presses of the open-mold class, as the name suggests, are provided with molds open at one end, and the pressure is obtained by the resistance offered to the material in passing through a gradually narrowing opening. Presses of this class are in use in brick and tile industries and the augur brick machine may be mentioned as typical. For fuel briquetting, open-mold machines are used commercially only for briquetting lignites and peats, although a press with open molds has been used to some extent in Belgium for briquetting washed scale containing as high as 20 per cent of water.

The following fuel briquet presses belong to this type:

1. The Exter press.

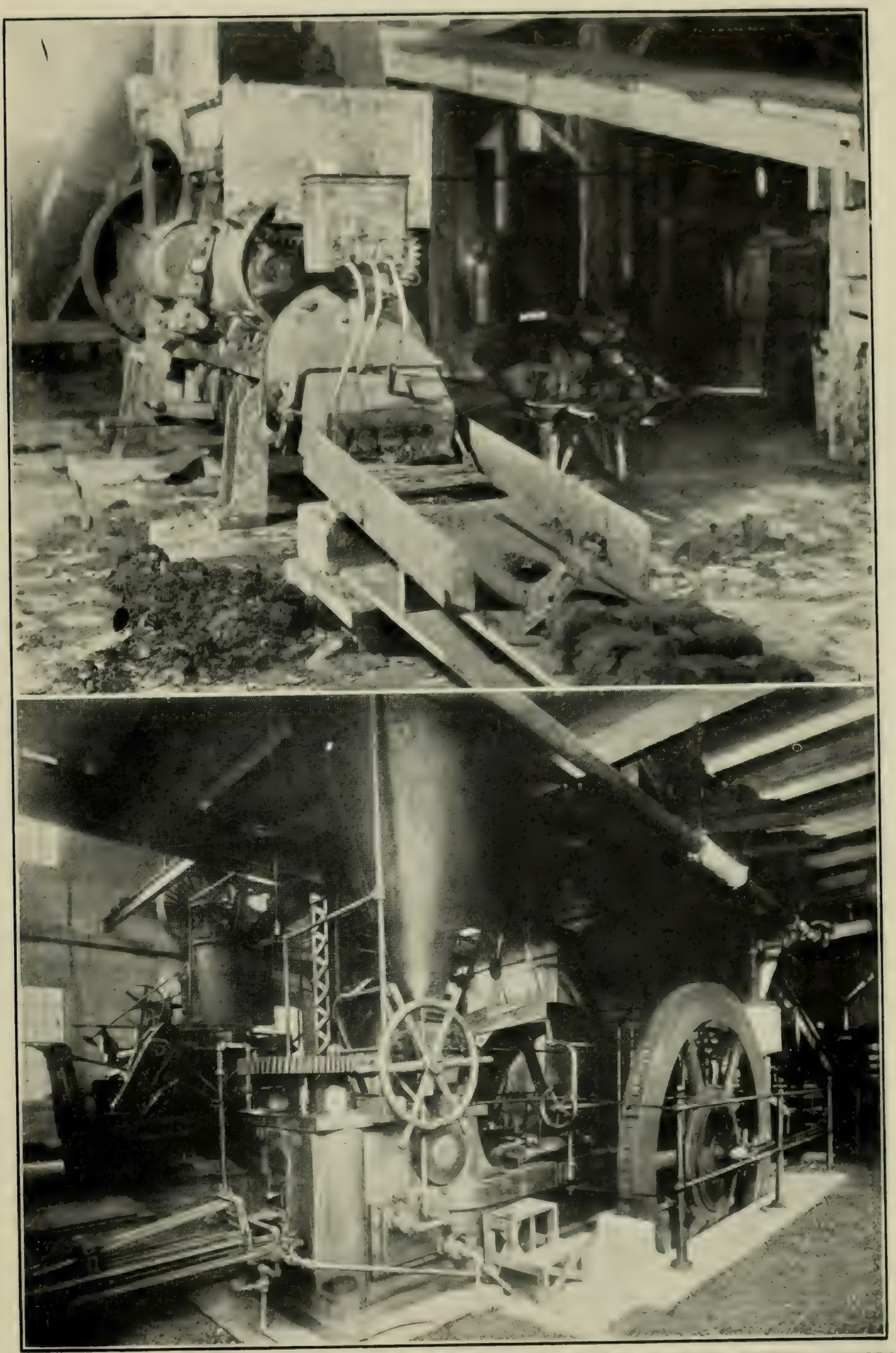
2. Bourriez press.

3. A press known in England as Johnson's briquet press, which however must not be confused with the Johnson press belonging to the Survey, which is of an entirely different type.

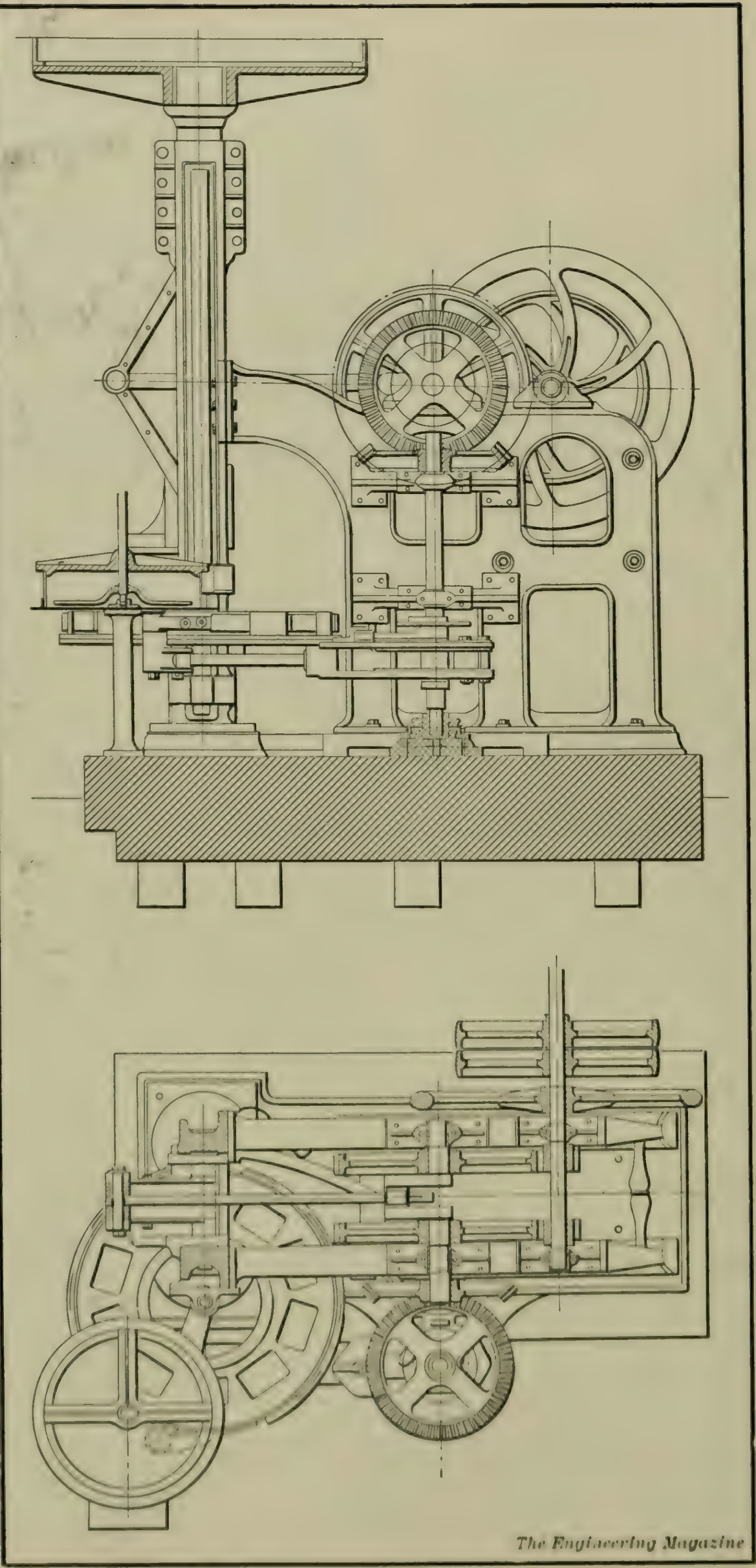
4. Max Everard's briquet press.

5. The Schlickeysen peat machine, which is typical of other peat machines.

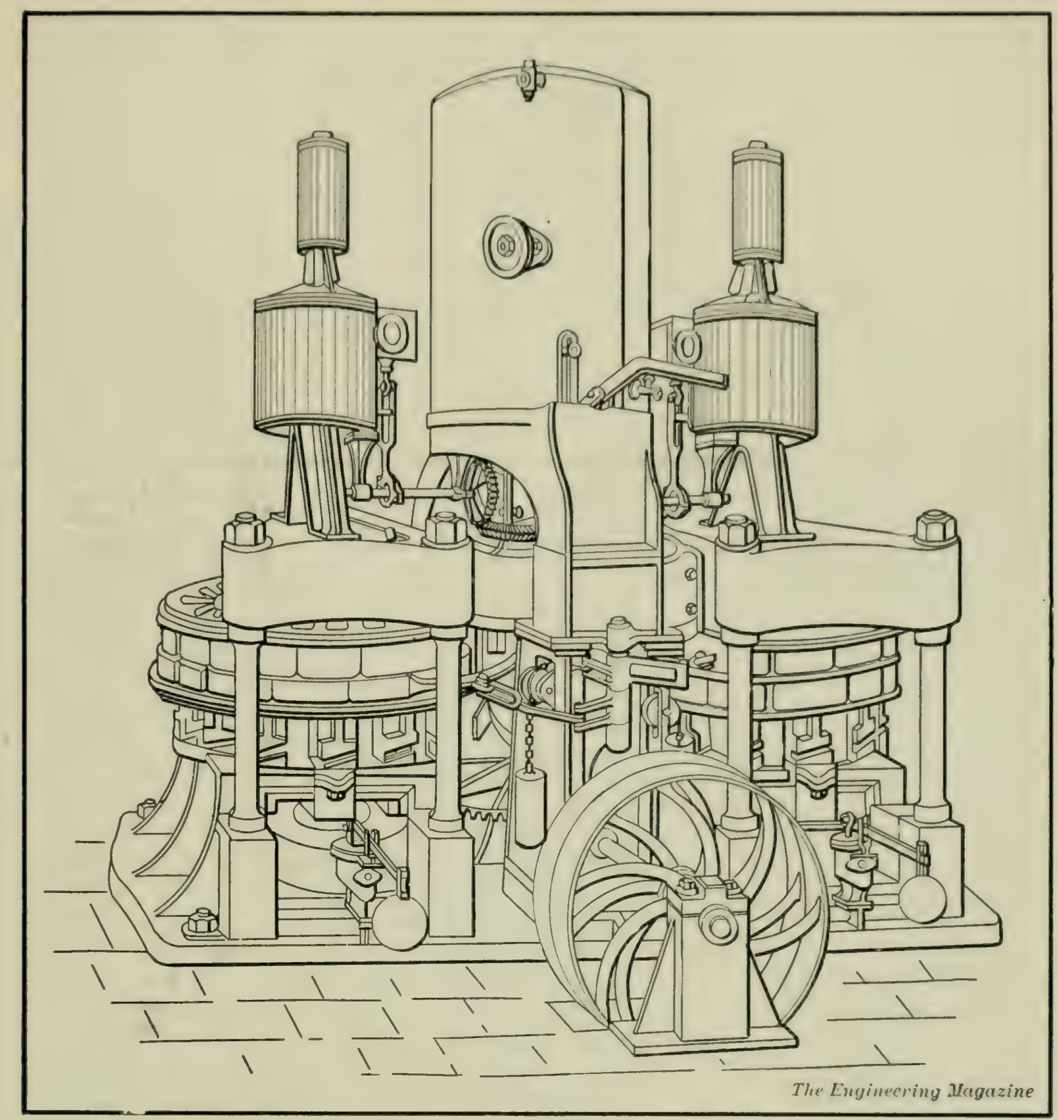
The Exter and Schlickeysen presses are shown in the illustration on the opposite page.



ABOVE, SCHLICKEYSEN WET-PEAT BRIQUETTING MACHINE. BELOW, EXTER LIGNITE AND PEAT BRIQUETTING PRESS.



THOMAS MIDDLETON BRIQUET MACHINE.



MAZELINE BRIQUET PRESS. A SINGLE-COMPRESSOR TYPE.

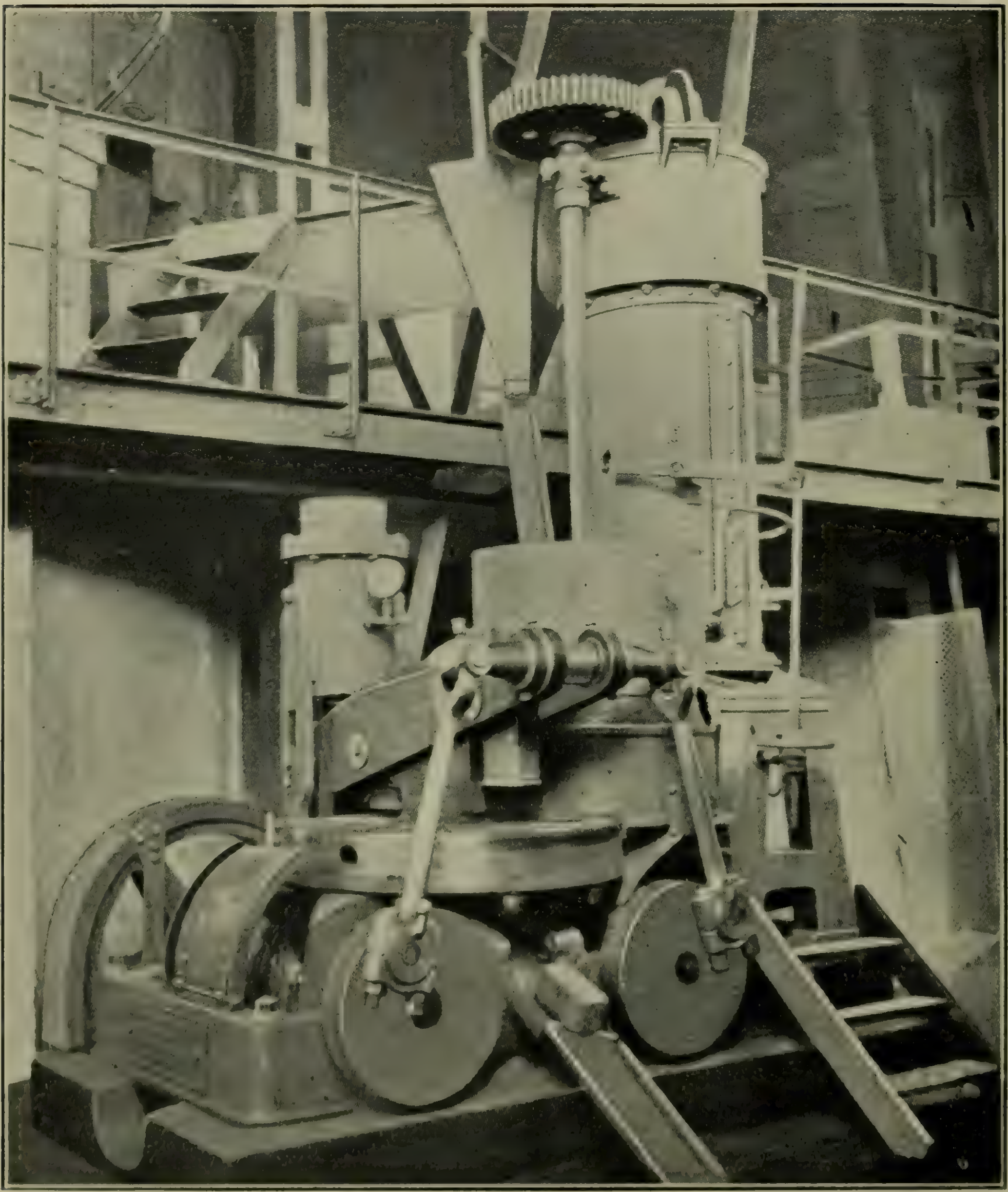
Class II. Briquet presses having closed mold may be divided into two types:

a. Single-compression machines.

b. Double-compression machines.

a. In the single-compression machine the material in the mold is compressed by a plunger from one side of the mold only, while in the double-compression machines both sides of the briquet are simultaneously compressed by double plungers, and the resultant briquets are more homogeneous than those made by the single-compression machines.

As types of the single-compression machines the following may be mentioned: Thomas Middleton's press, patented in England in

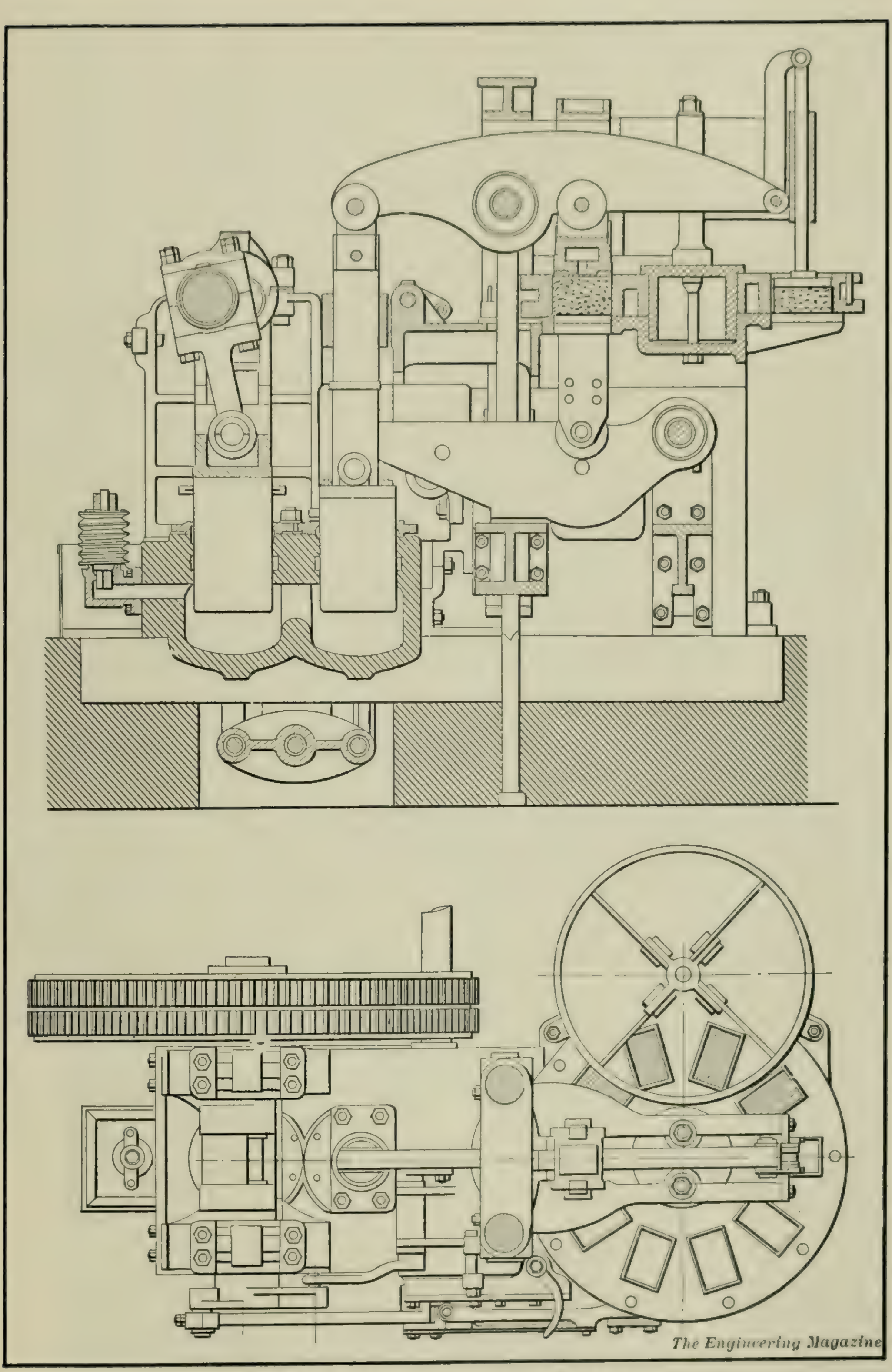


THE COFFINHAL BRIQUET PRESS.

1844; Mazeline press; Stevens press, manufactured by the Uskside Engineering Company.

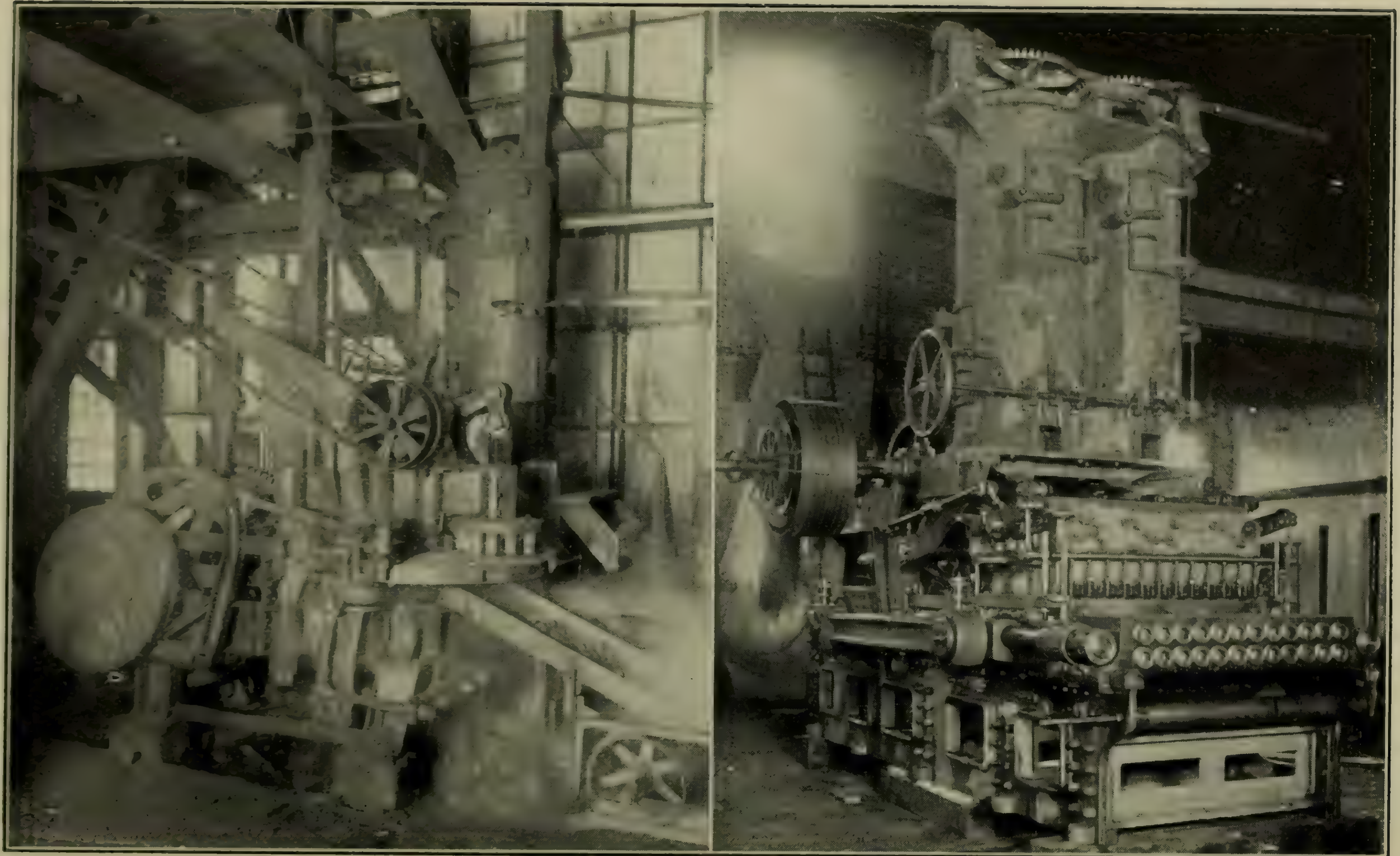
b. The following machines are of the double-compression type of press:

Coffinhal Bietrix machine.
Yeadons double-compression press.
Roux-Veillon press.
Johnson briquet machine.



The Engineering Magazine

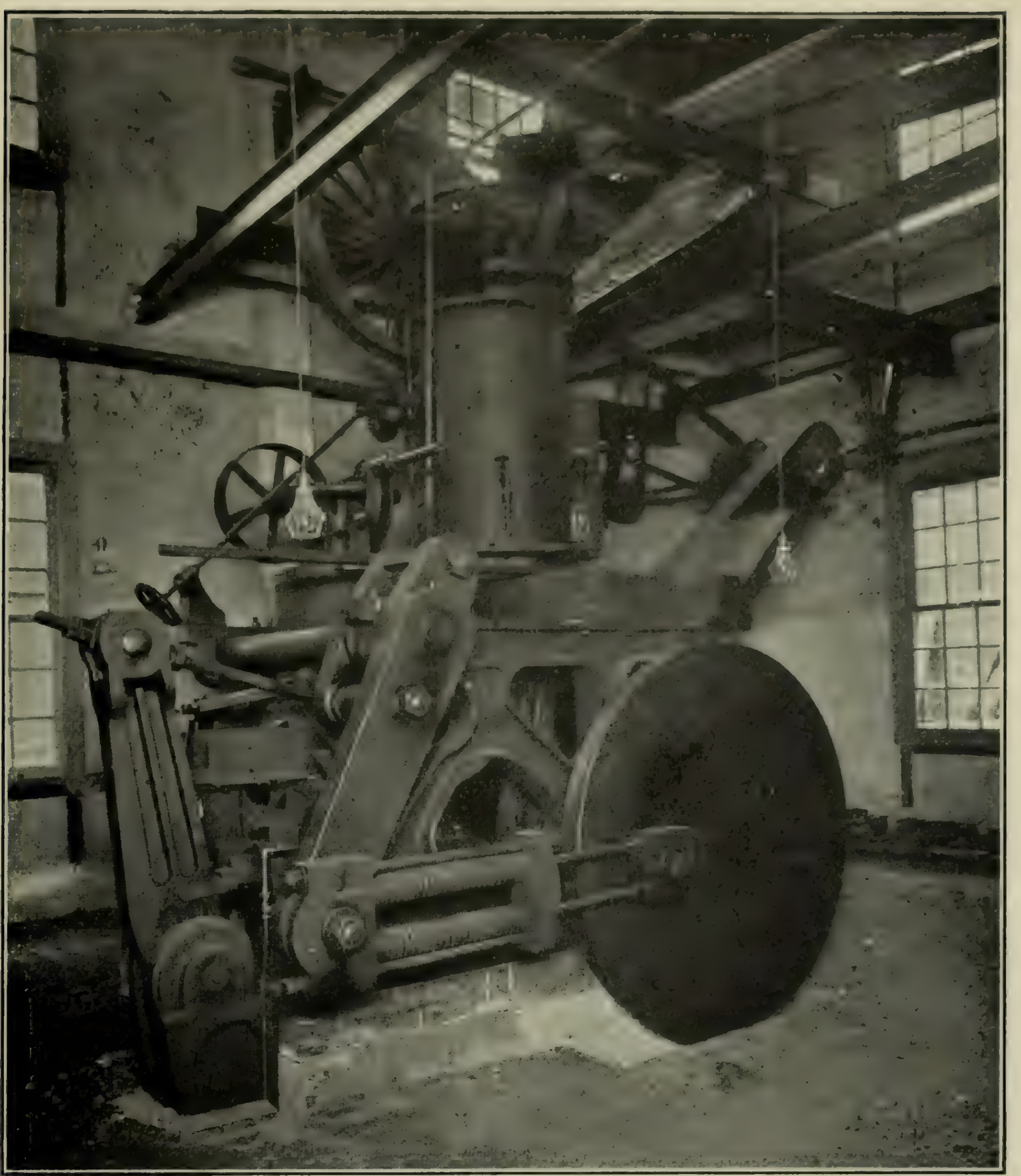
ROUX-VEILLON BRIQUET MACHINE.



MISNER BRIQUET MACHINE.

RENFROW BRIQUET MACHINE.

The Misner high-pressure machine was built for the Standard Briquet Fuel Co. and photographed in operation in their plant. The Renfrow machine is installed at St. Louis.



JOHNSON (ENGLISH) BRIQUETING MACHINE.

The following American presses are also of this type:

Renfrow briquet machine.

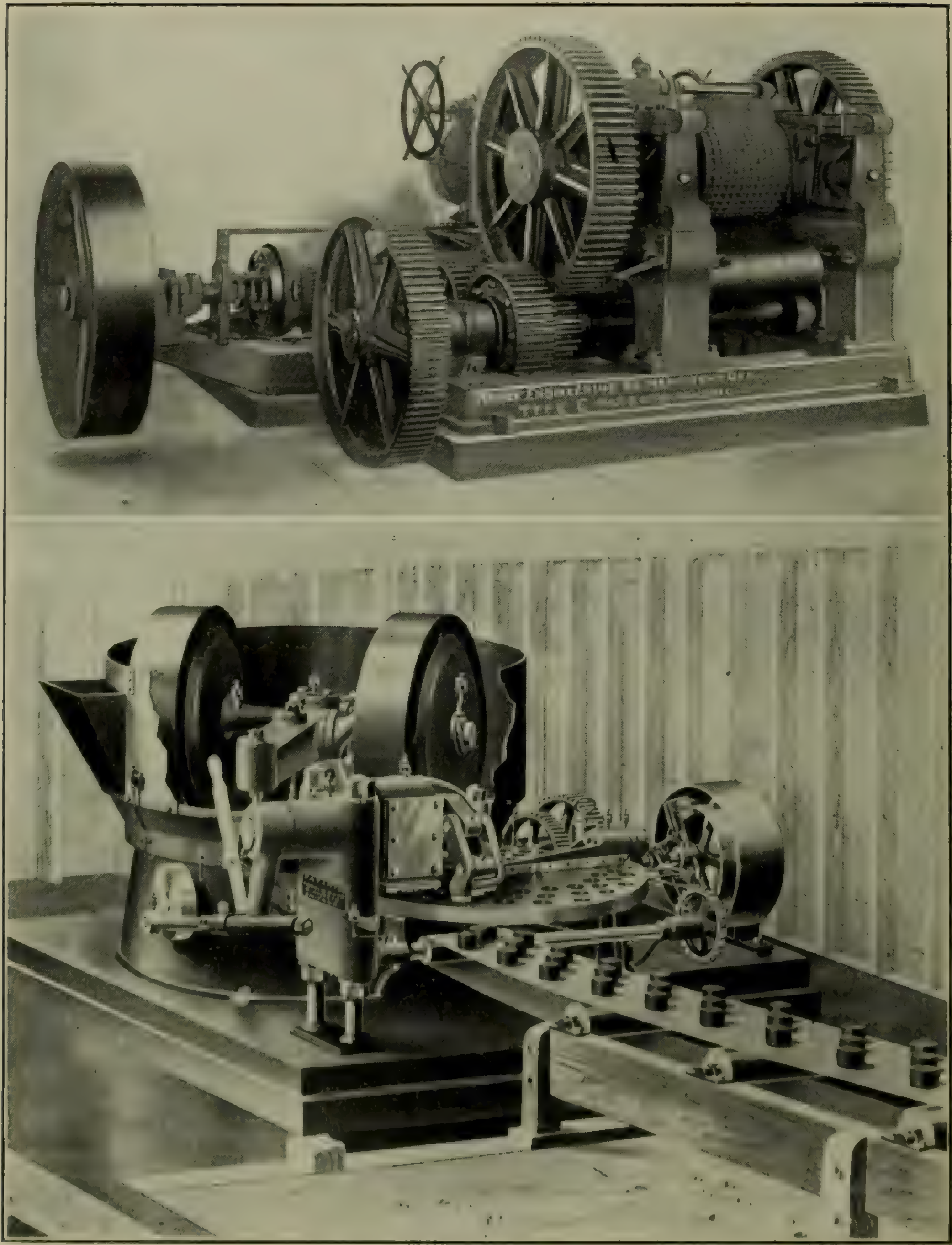
Misner press.

Class III. Tangential or rotary briquet presses. This class may be divided into two types:

a. Roll type of presses.

b. Rotary-plunger machines.

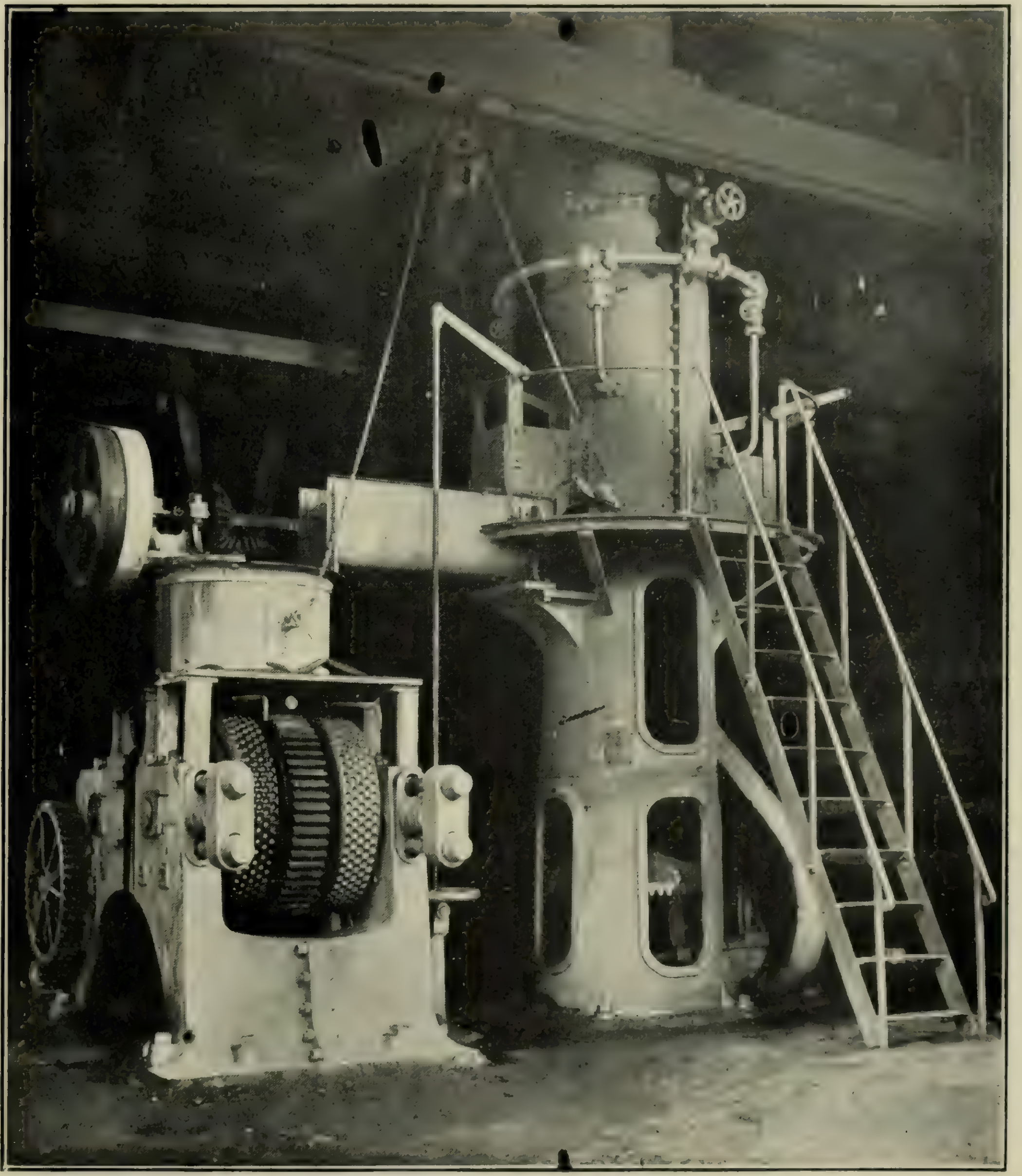
a. Roll type of press. This type of press consists of two rolls of the same diameter which are geared together so that one turns with the other at the same surface speed. In the face of these rolls pockets



ROTARY BRIQUET PRESSES.

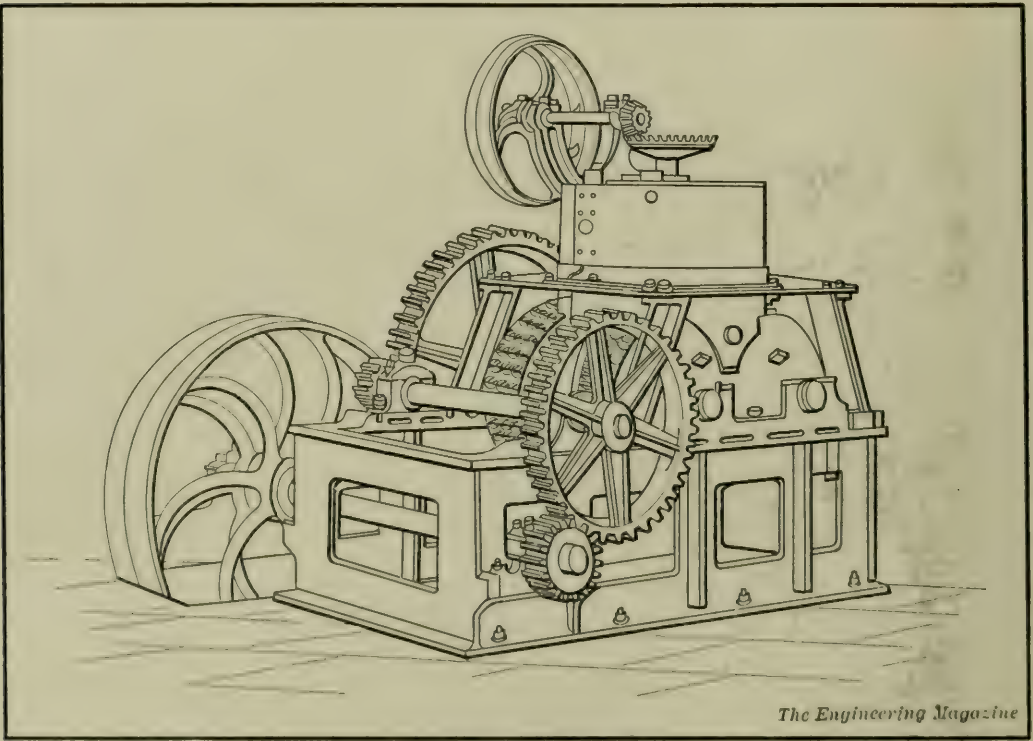
Above, briquet press by the Mashek Engineering Company, N. Y. Below, press of the Chisholm, Boyd & White Company, Chicago, Ill.

are arranged so that the pockets on each roll register perfectly with the corresponding pockets on the other roll. The prepared material is fed to these rolls from a hopper over them, and the turning of the rolls briquets the material. These presses have large capacity and are simple to handle, but they are not suited to make briquets weighing more than five or six ounces, and they require more binder than plunger machines to produce briquets of equal strength. They are especially adapted for making small-sized briquets and have been used in the United States in at least two of the successful briquetting plants. These machines have the advantage over plunger machines of being continuous in action so that there is no lost motion. They make briquets of various shapes, the pillow shape being the most satisfactory.



DEVILLERS BRIQUET MACHINE. ROTARY TYPE.
Robert Devillers, Brooklyn, N. Y.

The following presses are of this rotary or tangential type.
Mashek press. (see page 206.)
Mulheim and Zimmermann's press.
Fourquensberg's press.
Hall-Bjorling patent fuel machine.
Loiseau press.
Devillers press. (See page 207.)
Chisholm, Boyd & White press. (See page 206.)

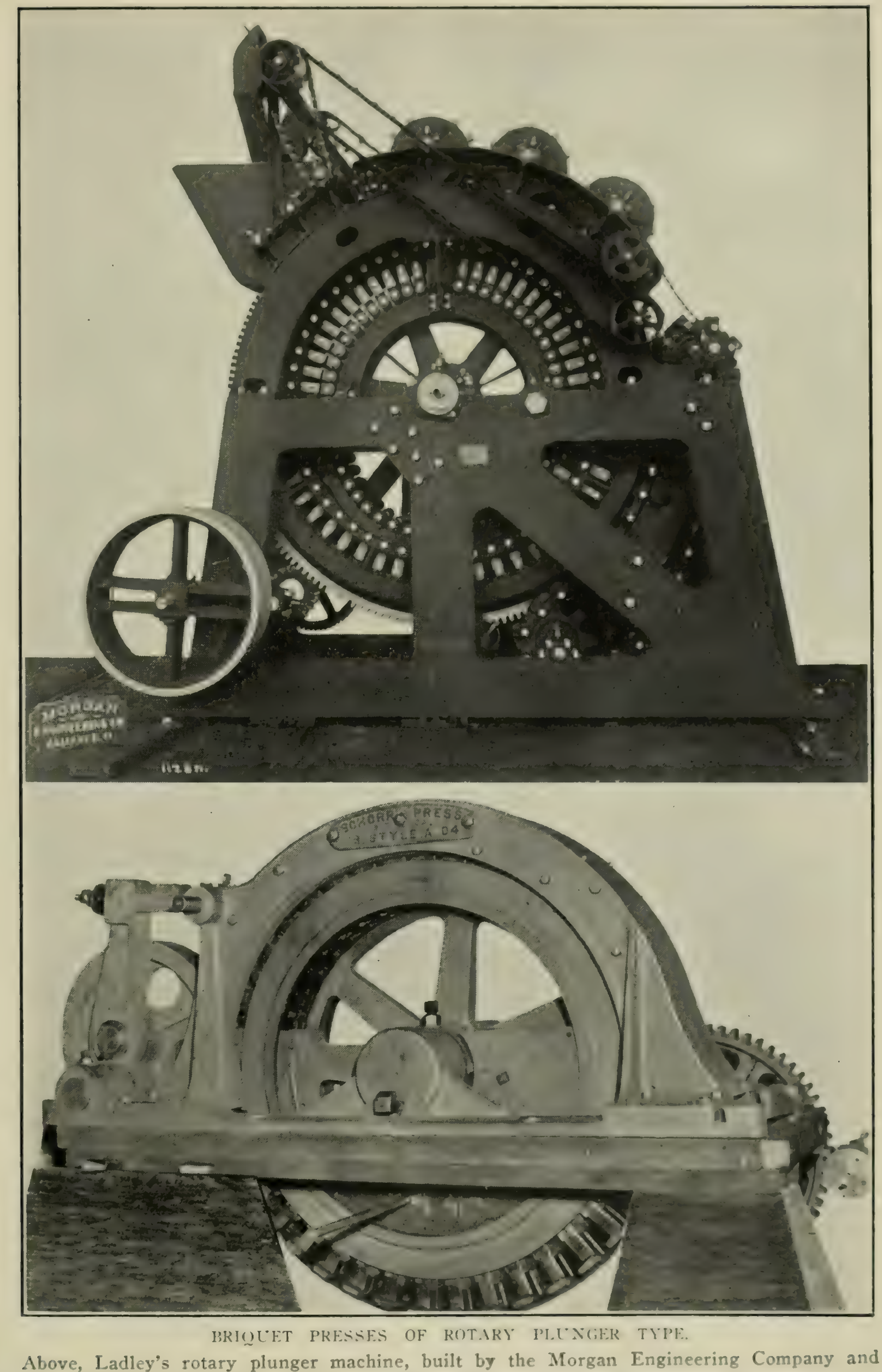


ZIMMERMANN BRIQUET MACHINE.

b. The rotary-plunger type. The distinguishing characteristic of this style of press consists in a series of plungers radially located in the rim of a wheel, some machines having only one ring and others having several rings of molds in the rim of the wheel. This type of press has the valuable features of continuous action, no lost motion, and high capacity of the roll press, and the added advantage of being able to make briquets with less binder and greater coherence than the roll machine while the size of the briquet that can be made on this machine is greater than that possible with the roll type. The following machines are of the rotary-plunger type:

Brogueaux press (France).

Ladley press, made by the National Pressed Fuel Co. of Indianapolis.



BRIQUET PRESSES OF ROTARY PLUNGER TYPE.

Above, Ladley's rotary plunger machine, built by the Morgan Engineering Company and illustrated by courtesy of the Indianapolis Pressed Fuel Company. Below, the Schorr press, made by Robert Schorr, San Francisco, Cal., and shown by courtesy of J. Bordollo, Kingsbridge, N. Y.

Schorr press, designed by Mr. Robert Schorr, a consulting engineer of San Francisco. (See page 209.)

ADVANTAGES OF BRIQUETTED FUEL.

Briquets, when properly made with a suitable binder, possess the following advantages over raw fuel:

1.—The even size of the briquets permits of a more regular and thorough combustion in the firebox or furnace, as the spaces that exist between adjacent blocks allow of even distribution of air through the fire and the pressure drop through the fire is also less.

2.—A good briquet holds its shape in the fire, so that even when coking coals are used they do not coke together sufficiently to cut off the air for combustion and the gases are burned as fast as distilled off, so that

3. Practically no smoke should be obtained from the combustion of good briquets.

4. Briquets generally burn to a fine ash rather than a clinker, as in the briquetting process the mixing and grinding thoroughly distribute the ash material, which in the raw fuel exists in spots and layers and is fused into clinker instead of falling through the grate.

5. The characteristic fineness of the ash from briquets allows of keeping a better fire with less attention and poking than is possible with raw fuel under the same conditions.

6. The evaporation per pound of fuel is greater for the briquetted than for the same coal in its natural state. This advantage is maintained at all rates of evaporation.[a]

7. The capacity of a boiler is considerably increased by the use of briquetted fuel.[a]

8. The weather-resisting qualities of many coals, and especially lignites, are greatly improved by briquetting.

9. Briquets apparently give a longer flame than run-of-mine coal.[b]

10. It is much easier to raise and to keep up steam with briquets than with run-of-mine coal.[c]

11. Higher rates of combustion are possible with briquets and consequently higher power.[c]

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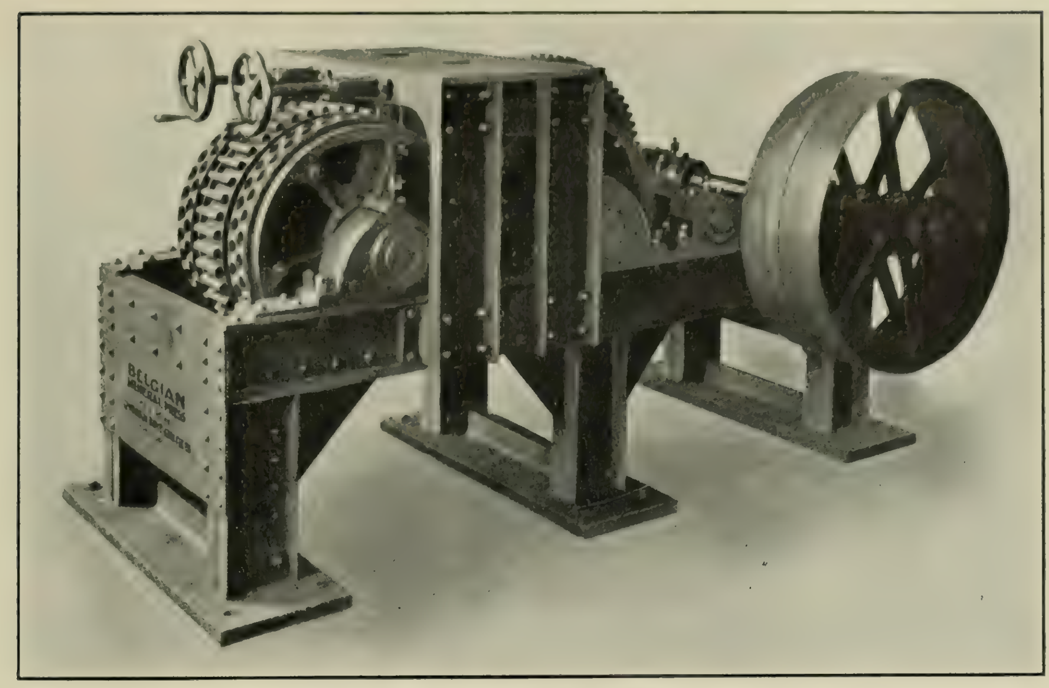
[a] Goss, W. F. M., in U. S. G. S. Bull. No. 363, "Comparative Tests of Run-of-mine and Briquetted Coal on Locomotives."

[b] Ray & Kreisinger, U. S. G. S. Bulletin No. 403, "Comparative Tests of Run-of-mine and Briquetted Coal on the Torpedo Boat Biddle.

[c] Ray & Kreisinger, U. S. G. S. Bulletin No. 412, "Tests of Run-of-mine and Briquetted Coal in a Locomotive Boiler."



BELGIAN EGGETTE PRESS.
Chisholm, Boyd & White Co., Chicago.

12. When properly made there is less loss from breakage during transportation of briquets than of run-of-mine coal.

13. The danger of spontaneous combustion in storage piles is eliminated if the fuel is stored in the briquetted form, and this characteristic of briquets has made briquetted fuel favored for storage by European countries.

14. The block-shaped briquets may be piled in regular piles and occupy less space than the run-of-mine or slack from which they were made.

15. Briquets, especially those made from lignite, have a higher heat value than the raw fuel from which they were made, this improvement resulting from the higher heat values of the binder added to bituminous and anthracite coal to briquet them, and from the evaporation of water from the raw lignite in the case of lignite briquets.

While the United States has been more fortunate than European countries in the amount of good bituminous and anthracite coal which it possesses, still the time is not far distant when the American people must realize that if the price of coal is not to reach such a high figure that the industries of the United States cannot compete with foreign industries, we will have to be more careful of what is now wasted in the process of mining; and then we may look for the gen-

WESTERN FUEL COMPANY'S BRIQUET PLANT, OAKLAND, CAL.
Equipped with Schorr presses.

eral adoption of briquetting as a partial solution of the problem of mine waste.

Briquetting schemes have failed in certain instances in the past because they were not under proper technical supervision, or the supply of raw fuel or binder was uncertain, or poor judgment was shown in the location of the plant to supply markets already supplied with good fuel at low prices. Most of the briquetting plants in European countries are located at the mines and are owned by the mine operators, so that they may utilize the waste from the mines, in the case of the hard fuels, or can make low-grade fuels such as lignites into briquets without transportation charges having been paid on the raw material.

Success in the fuel-briquetting industry in the United States will only be attained when American mine operators become sufficiently interested in this method of utilizing their mine waste, or, in the case of lignites, making a good fuel from inferior raw material, to install complete briquetting plants at their mines. With proper equipment and superintendence, plants so located should be a good investment for the operators.

Production of Briquets.

According to figures compiled by Mr. Robert Schorr, the world production of all kinds of briquets in the year 1885 was 4,750,000 metric tons, or 1.0 per cent of 475,000,000 metric tons, the total coal and lignite production of that year. The total coal and lignite production for 1908 was 1,035,000,000 metric tons and from this 26,000,000 metric tons of briquets were manufactured, or 2.52 per cent of the total coal and lignite production for that year. This shows that the coal production of 1908 was 218 per cent of that of 1885 and the briquet production in 1908 was 549 per cent of that in 1885, so that in twenty-five years the coal and lignite production has a little more than doubled, while in the same period the briquet production has increased 5½ times.

The recent briquetting tests of the United States Geological Survey have determined that some American lignites can be briquetted successfully without adding binding material to them. These tests were made with an equipment imported from Germany especially for these tests. The heat value of the briquets manufactured was about 50 per cent greater than that of the raw material, this increase being due to the reduction in moisture by the process of briquetting. As about 1.4 tons of raw lignite was required to make one ton of the briquets, the net improvement in heat value of the lignite by briquetting was about 10 per cent. The cost of this briquetting, exclusive of the material for briquetting but including labor, power, depreciation, maintenance, and 8 per cent interest on investment, was estimated from these tests to be from $1.35 to $1.72 per ton of briquets, this figure applying to those varieties of lignites, only, which can be briquetted without added binding material.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

By Frank zur Nedden.

V. SPECIAL HIGH-LIFT TURBO-PUMPS.

Mr. zur Nedden's critical discussion of the centrifugal pump, the concluding part of which is here published, has already dealt with the mechanical and hydraulic losses of turbo-pumps, solutions of the problem of balancing axial thrust, structural features and manufacturing considerations, and the turbo-pump diagram and its practical interpretation in service. We now present his concluding section on Special High-Lift Turbo-Pumps.—THE EDITORS.

THE foregoing studies certainly show that the technical peculiarities of turbo-pumps, if ignored, might give rise to difficulties. If, however, the proper type is chosen, with full appreciation of these peculiarities, and if it is placed in proper working conditions, it is now proved by a larger number of plants that high-lift turbo-pumps are an ideal form of apparatus economically and especially in operation. Figure 42 shows the attractive appearance of a turbo-pumping plant. An excellent effect is secured by placing both suction and discharge pipes underground and the simplicity of operation corresponds to the external appearance. The compact arrangement of the turbo-pump is well shown in Figure 43, exhibiting a fine combination of a four-stage high-lift centrifugal pump by Messrs. Weise and Monski, with an 850 brake horse-power, three-phase alternating-current motor by the Bergmann Electricity Works. This pump is placed in the Karl Funke shaft of the Essener Steinkohlen-Bergwerks-Verein, and raises about 1,550 gallons a minute against a head of 1,200 feet at 1,480 revolutions.

I studied some interesting details of the space economy possible in a turbo-pump plant at one of the large coal mines at Upper Silesia. A Jaeger high-lift turbo drainage plant of 3,000 litres (670 imperial gallons per minute) was placed beside a piston pump of equal capacity.

Sections of the space required for each of the installations are shown relatively drawn to exact scale in Figure 44. Emphasis should be placed on the fact that the piston pump requires a concrete foundation 9 feet deep, while the turbo-pump could be placed on a simple

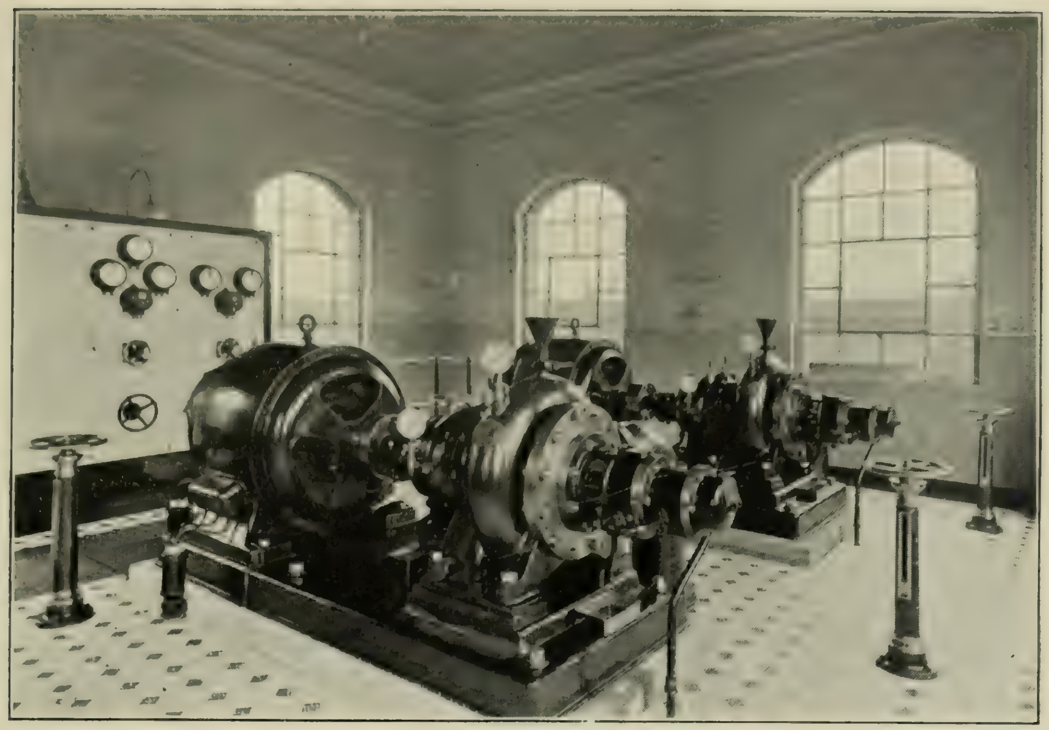


FIG. 42. TWO TURBINE WATERWORKS PUMPING UNITS, BERLINER MASCHINENBAU A. G.

flooring supported by I-bars, thus affording an excellent sump arrangement. Finally, it should be noted that as a rule in mines long narrow chambers are less expensive and safer against movement of the ground than broad high ones. The important influence of these considerations, which are by no means secondary, is illustrated by the following calculations. The thickness of masonry for the centri-

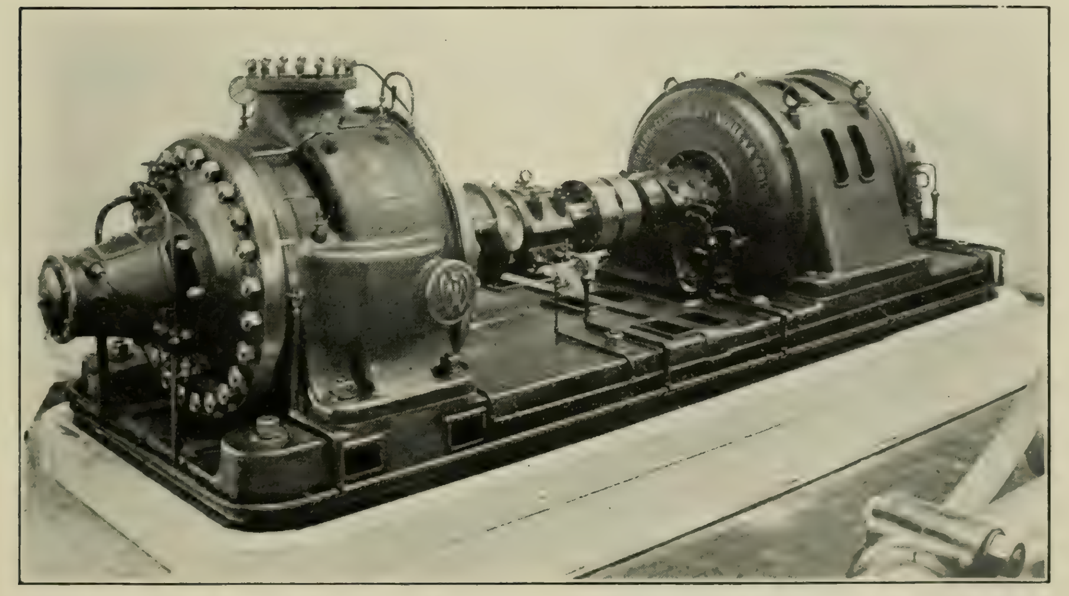


FIG. 43. WEISE & MONSKI FOUR-STAGE HIGH LIFT TURBINE PUMP DIRECT-COUPLED TO THREE-STAGE ALTERNATING-CURRENT MOTOR.

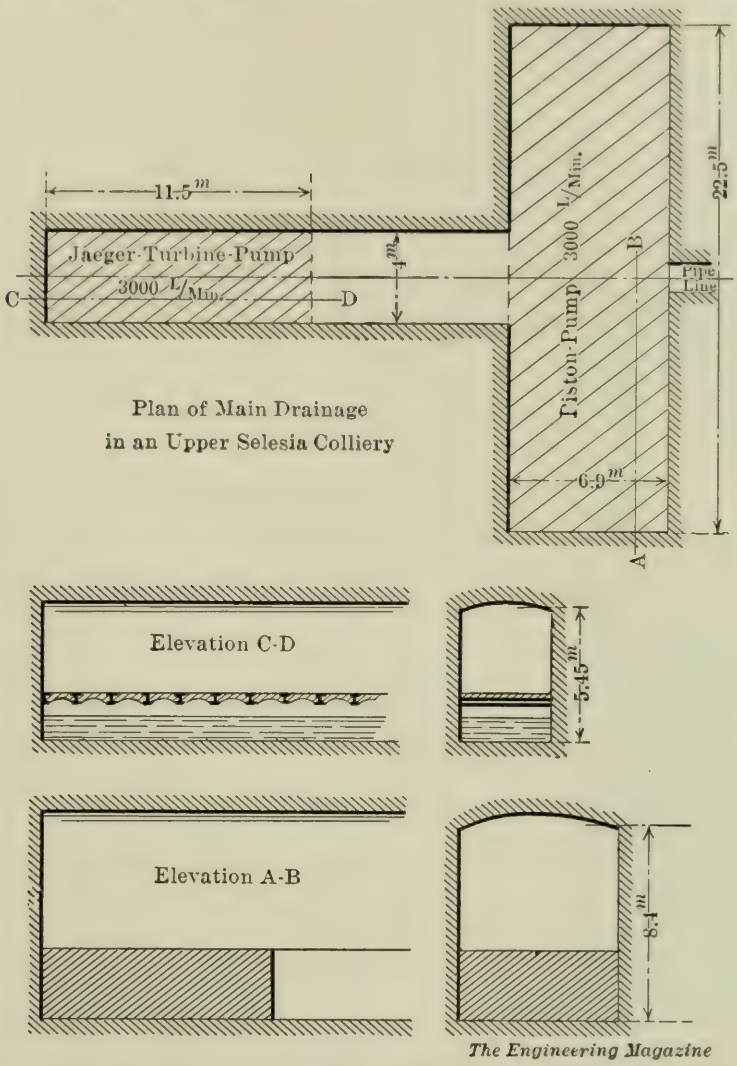
Lifting 1,550 gallons per minute against a head of 1,200 feet; 1,480 r. p. m.

fugal pump gallery was about 1.25 metres, while for the larger room provided for the reciprocating pump it was 1.50 metres. The cost figures for the installations are tabulated below:

	Piston Pump	Centrifugal Pump
Inside dimensions clear	6.9 × 8.4 × 22.5 = 1,300 cu. metres	4 × 5.45 × 11.5 = 251 cu. metres
Additional for thickness of masonry	3 metres each way	2.5 metres each way
Resultant volume of rock to be blasted	9.9 × 11.4 × 25.5 = 2,875 cu. metres	6.5 × 7.95 × 14.0 = 723 cu. metres
Cost of blasting according to figures given by the management, 40 marks ($10 or £2) per cubic metre or in total	2,875 × 40 = 114,700 marks	723 × 40 = 28,900 marks
Total volume of masonry	2,875 — 1300 = 1,575 cu. metres	723 — 251 = 472 cu. metres
Cost of masonry according to figures given by the management 15 marks, (15 shillings or $3.75) per cubic metre or in total	1,575 × 15 = 23,600 marks	472 × 15 = 7,090 marks
Total cost of pump room	114,700 + 23,600 = 138,300 marks	28,00 + 7,090 = 35,990 marks
Difference in favor of turbo-pump		102,310 marks ($25,550 or £5,120)
Guaranteed efficiency of pump	92 per cent	68 per cent (intentionally assumed low; guaranteed 72 per cent)
Guaranteed efficiency of motor	90 per cent (slow speed)	92 per cent (high speed)
Total efficiency	82.8 per cent	62.6 per cent
Required brake power	3,000 litres against a head of 540 m. static or 550 m. gauge. 326 kws.	do. do. with safety surplus of 3 per cent. 444 kilowatts
Difference to the disadvantage of the turbo-pump per hour of working		118 kilowatts

On the basis of 3 pfennig (¾ of a cent or a little more than a farthing) per kilowatt hour as given by the management of the mines, and of 3,600 working hours per year (calculated from average conditions) these 118 kilowatts represent an additional operating cost per annum for the turbo-pump of

118 × 0.03 × 3,600 = 12,700 marks ($3,175 or £635).



The Engineering Magazine

FIG. 44. RELATIVE SPACE ECONOMY OF TURBINE AND RECIPROCATING PUMP INSTALLATIONS.

The cost of the pump-room must be amortised at at least 5 per cent, and interest on its cost must be reckoned at 4 per cent, with an addition for cost of repairs estimated at 1 per cent. The total capitalization of this item, therefore, for purposes of comparative determination of operating costs must be taken on a 10 per cent basis. Consequently 12,700 marks additional expense for drainage by the turbo-pump correspond to a difference in invested capital of 127,000 marks. Therefore, there remains to the debit of the turbo-pump account an amount equal to 127,000 — 102,310 = 25,000 marks ($6,250 or £1,250). This, let us remember, applies to the pump chamber only.

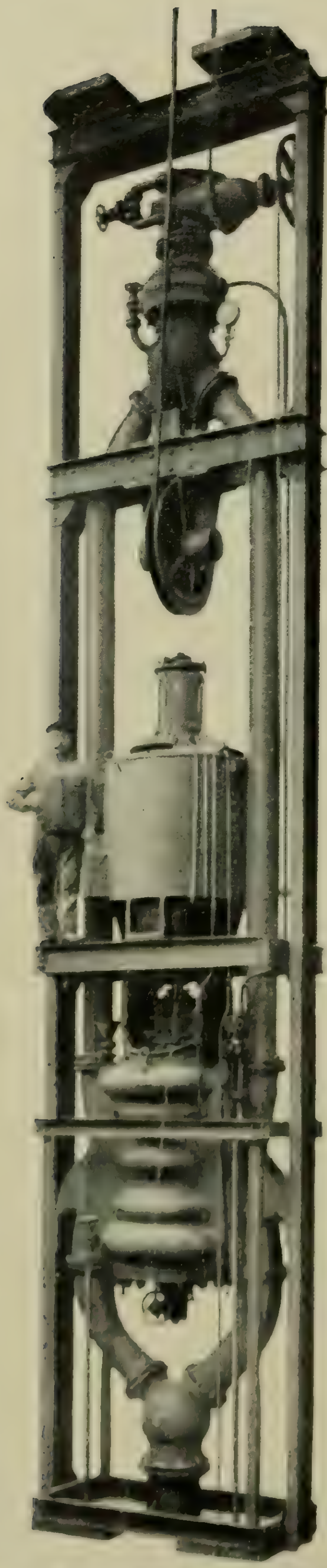


FIG. 45. SULZER MULTI-STAGE HIGH-LIFT TURBINE SINKING PUMP.

So far as machinery is concerned, the reciprocating pump combination costs about 97,000 marks ($24,250 or £4,850), while the turbo-pump combination costs only about 26,000 marks ($6,500 or £1,300). Even if we suppose that the turbo-pump will be used up in one-half the time which the reciprocating pump will last, there will nevertheless remain a difference of capital cost in favor of the turbo-pump equal to 97,000 — 26,000 × 2, or 45,000 marks ($11,250 or £2,250).

The total comparison of the roughly calculable capital or capitalization costs therefore leaves us with 25,000 marks to the debit of the turbo-pump and 45,000 marks to the credit, or a credit balance in favor of the turbo-pumping plant equal to 20,000 marks ($5,000 or £1,000). This calculation does not take into account costs of lubrication, repairs, wages, etc., which are decidedly lower with the turbo-pumping plant than with reciprocating pumps. Even though the bases of this comparison will be somewhat different in other countries and under other mining conditions, there still remains a balance of safety and convenience in operation in favor of the turbo-pumping plant, which no mining man should undervalue.

The compact arrangement of turbo-pumping combination becomes of incalculable value in the sinking of watery shafts. Sinking pumps of turbo form are arranged vertically. In spite of the apparent simplicity of design the difficulties in the construction of these units are immensely increased. Only a few builders have succeeded in mastering them. Among Continental firms Messrs. Sulzer Bros., of Winterthur, have been eminently successful. Figure 45 shows an example of their product built for the Donnersmarkhütte, Zabrze, Upper Silesia. Its most striking peculiarity is that the first stage is placed at the top of the pump. Consequently the suction pipe must pass alongside of the pump to its highest point, whereas the discharge pipe ascends from the lowest point. To secure exactly symmetrical distribution of weight both pipes are divided into two branches and must be intertwined as shown distinctly in Figure 45. The principal advantage of this arrangement is that the axial thrust is upward, and if the dimensions are properly chosen it balances the weight of the rotating parts; that is, the impeller wheels, the rotor of the motor and shafts. The thrust bearing has to take up only shocks caused by sucking air or other incidents occurring often in the use of sinking pumps.

The pump shown in Figure 45 has attained a certain celebrity, being the first really large vertical sinking pump, and having saved by its excellence a valuable shaft. Prof. Herzog, of Zurich, outlines its almost dramatic history in an article on Sulzer high-lift turbo-pumps in the *Schweizerische Elektrotechnische Zeitschrift,* 1905. He says:

> In the Donnersmarkhütte a shaft 400 metres deep was to be sunk. At a depth of only 100 metres springs were encountered so large that the miners had to flee and the shaft was flooded. While he was making his escape the mine foreman measured the rise of water, the calculation showing about 15 cubic metres per minute. Attempts to drain the mine by steam pumping had to be abandoned as unsuccessful, because in addition to needing many repairs the three steam pumps, which altogether raised 10 cubic metres per minute, filled the entire area of the shaft so that scarcely enough room was left for a bucket. The shaft was therefore again abandoned. To save if possible the loss of this valuable working, it was finally decided to give the Sulzer high-lift centrifugal pumps a trial. For this purpose three sets, (like Figure 45) were installed in the shaft, each delivering 8 cubic metres per minute to a height of 160 metres at 970 revolutions—a total delivery of 24 cubic metres per minute, while sufficient space for two buckets was still left in the shaft. Vertical alternating-current motors are used for driving. The weight of each suspended pumping set including the full delivery pipe amounts to 52,000 kilogrammes, giving a stress of 26,000 kilogrammes on each cable. These are steel wire ropes of 62 millimetres diameter.
>
> Current is supplied from a power station 6 kilometres from the shaft in which two 1,000 horse-power gas engines, operating on furnace gas, were installed. The tension in the transmission line is 8,000 volts, which is transformed at the terminals to 1,000 volts.
>
> Drainage was accomplished very quickly with these sinking pumps, as one unit alone on account of the small head at the beginning of the operations delivered 12 to 15 cubic metres per minute. Further, during the progress of sinking and blasting these pumps gave no trouble whatever. After the sinking was finished these pumps were fixed in the shaft and are now used as a stationary drainage plant.

The centrifugal pump is constantly conquering new domains. For example, it has begun to replace the reciprocating feed pump in large central power stations. It is especially suited to this service by its self-adjusted regulation and its ability to work for a certain time against the closed discharge pipe. It may be left quite to itself with a changing volume of feed-water delivery. Only in the boiler plants of electric power stations, where electric current may be obtained at low rates, will this type of pump be economical. As it is especially adapted to the delivery of small quantities of water against a high pressure it is often speeded to the highest point, even up to 3,000 revolutions a minute. Especially on ship-board it has lately been adopted to an ever-increasing extent because of its small weight and space requirements.

One of the most interesting special uses for the turbo-pump is the supply of water under pressure for the service of heavy hydraulic machinery in rolling mills and similar works. A very valuable advantage of the turbine pump in this service lies in the fact that a troublesome accumulator system is no longer needed and the turbine pumps may be connected to the piping system without any intermediary appliances. Only in very large systems in which the length of the pipe lines (and consequently the quantity of water contained therein) is very great does it become advisable to protect the pump from the violent reactions caused by the acceleration and retardation of the large water column when the governing valve is suddenly opened and closed, as it so frequently is in rolling mill work. Special protective arrangements are then applied. Their features as well as the choice of the most suitable form of blades (a matter of extreme importance in this kind of work) are carefully guarded secrets with the very few prominent firms who have learned them by large experience. When these precautions have been observed, the operation becomes almost ideal. A whole room full of hard-working piston pumps, with all the intolerable difficulties which valves for pressure of 50 atmospheres and more always occasion, is replaced by a single electric-driven turbo-pump combination. It requires one machinist instead of half a dozen, and runs uninterruptedly day and night for many months without requiring the smallest repairs. For, given pure water, the turbo-pump under continuous operation without stoppage finds its best working conditions, as all strains are in the form of steady or dead load and do not differ from the conditions of rest.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

The policy and methods of foundry management proposed by Mr. Claydon are extremely simple and reasonable. They require no burdensome increase of "paper work." Nevertheless they are sufficient to provide considerable knowledge of pertinent and valuable facts about the location of the profitable and unprofitable parts of a business, and the actual value received for every dollar expended. His article now published will be followed next month by one upon "The Handling of Stores"; in July he will discuss "Keeping Down Foundry Expenses."—THE EDITORS.

COMPETITION is the most insistent fact in the experience of the business man of today. From the small jobbing shop up to the large locomotive works, the cry is the same: "We cannot make the headway we used to;" and naturally the inquiry is: "What is the reason?" "Times change and we change with them," said one of the wisest of sages; yet I venture to think had he been living now his adage would have read "Times change and we *do not* change with them." This, in my opinion, is at the root of a good deal of our loss of business. Some of us are still content to run along the old lines, for the very intelligent (?) reason that "My father made a good living out of it, and I can do the same." Unfortunately, however, this theory does not work out in practice. To go with the times means to be up to date; and this in turn means that a manufacturer must know with certainty, at any time, how his business is progressing. This can be accomplished only by looking after the details, which perhaps when competition was not so rife our forefathers could afford to let slide. In these days of "hustle" it does not do for us to stand and wonder why our business is not flourishing—it is "up to us" to know; and it is only by a systematic handling of our affairs that we are enabled to detect the many leakages that exist, and effect economies compatible with efficient management.

Apart from the diverse opinions held by cost accountants as to the working out of a cost system, business men themselves are very sceptical about undertaking any so-called "innovation," especially when they get the idea that it means the employment of what they are pleased to call "non-productive" labour for its efficient carrying out. They lose sight of the fact that with a proper cost system in force, as has been proved in countless cases, they will be able to effect considerable financial saving, and to make their business a thoroughly profitable concern. It is no uncommon remark that a cost system involves too much red tape. Superficially it does; but when accurate results are obtained it becomes of vital importance, especially, as I have pointed out, when we are able to effect economies which but for our cost system, we would never have dreamt of effecting. Provided, then, these conclusions are reached, our "non-productive" labor becomes surely very profitable, if not from a manufacturing point of view "productive."

In this article it is my intention to point out the necessity of an accurate record being kept of foundry employees' time, and a proper distribution being made of the work performed by them in a given period. Many an employer of labor is confronted with the statement that during the financial year $100,000 has been spent on wages alone in his establishment; and often, too, the knowledge comes as no small surprise, unless he has details at hand showing what return he received from his employees for this output; and he may very reasonably wonder whether this amount has actually been earned by those employed by him. On the other hand, however, if you were to ask an employer if he thought his employees had turned out the best results for the money paid them he would in all probability greet you with the remark that he was not such a fool as to pay for what his men did not earn. But is he sure of this? In a large manufacturing plant it is very easy for loose and inefficient methods to prevail unless a very strict watch is kept upon everything. Obviously, then, it is a necessity that we have some arrangement whereby we are able to keep tab on our employees, and thus see that we are obtaining a just return for our expenditure. "Waste not, want not" is a very old proverb, which it might be well for us to consider a little more—especially in a foundry business where the opportunities for waste are so enormous.

In a foundry of any magnitude it will be conceded that a timekeeping system of some kind is an essential. Various systems are in vogue, each one doubtless having its own peculiar advantages. For instance, the "metal check" system is considered by some to be a good method. Under this plan, a successful applicant for work is entered on the pay-roll sheets under a given number. On his starting to work he applies to the timekeeper for a check bearing his number, without which he cannot even enter the shops. On his arrival at his particular workshop he deposits this check in a box in his shop provided for the purpose. This box is in charge of the foreman of the department (or an assistant timekeeper) whose duty it is to lock up these boxes immediately after the whistle has blown for starting work, the timekeeper at the same time shutting his wicket. A late arrival has to apply in the office for his check, the timekeeper noting in his book the time at which he starts work. Now whilst not altogether condemning this method, I would like to point out what appear to me to be its weak spots. In the first place, it would seem that too much time is taken up by the timekeeper in arranging and giving out these checks at certain intervals during the day. As you will readily see, the same process has to be gone through at the lunch hour and also on the men quitting at night. Again, where a large number of hands are employed it is practically impossible for a shortage in a man's pay to be satisfactorily determined under this method. What I mean is this: assuming that after the men have been paid, one of them reports to the timekeeper that he is short paid, the time sheets are turned up, and it appears as far as the timekeeper's books show the man has been correctly paid, whilst it is not at all improbable that the man's money was not correct, and an injustice was done him, which under the metal check system it is impossible to detect.

Once again:—in addition to the two objections I have already pointed out, I think that there is a great opportunity for a timekeeper to show favoritism if he should so desire, and with slight chances of detection; this is surely a very strong disadvantage of this system. There seems to be no reason whatever why the time clerk cannot, if he so chooses, show partiality to any particular "friend" he may have in the works. For example, what is there to prevent this official from entering up in his book 10 hours for which a man did not work? What means have you of detecting this fraud? Doubtless if it was carried on to any extent it would be found out, but "prevention is better than cure."

We often say "What can't speak can't lie;" and this leads me to speak of the time clocks, which are being used in plants more and more every day. I think it is scarcely necessary for me to go into details as to the mechanical working of these, as most of us are acquainted with them, although we do not make use of them. As far as I can see, however, their method of registering a man's time leaves very slight chances of dishonest practises, and as far as day workers are concerned none of these should be short in their pay. On entering the works in the morning, a man goes first thing to the

Machine Shop PAY ROLL FOR FORTNIGHT ENDING December 28th 1909

No.	NAME	RATE	15 W	16 T	17 F	18 S	20 M	21 T	22 W	23 T	24 F	25 S	27 M	28 T	TOTAL HOURS	ADVCS.		SUBS.		AMOUNT		REMARKS
37	J. Thompson	2 25	10	10	10	10	10	10	10	8	7	–	–	5	90	–	–	–	–	20	25	
35	W. Smith	2 00	10	9	10	8	–	10	7	5	10	–	7	3	Piece Work	–	–	–	–	26	18	see Piece Work sheets
39	H. Jones	2 50	10	10	10	5	10	10	10	10	10	–	10	10	105	–	–	–	–	26	25	

The Engineering Magazine

FORM FOR PAY ROLL.

clock and punches his time, on the number by which he is known on the pay-roll sheets. This in turn registers on a slip, affixed inside the clock, the exact time at which he entered the works. Assuming that 7 a. m. is the recognised time for starting work, the clock watcher (possibly a trusted employee) at (say) three minutes past the hour, will lock the clock, and by moving a lever on the face of it he places the disc in position for the men to punch when they stop work at the noon hour. The same process is gone through on their return, and on quitting work at night. At the end of the day this clock slip is removed by the timekeeper, and a new one placed in position for the following day. Now on examining the clock slip we find a record somewhat similar to the following:—

No. 56. 6-45. 12-01. 12-57. 5-32.

Here, then, is a true record of the time actually worked by the man corresponding to No. 56. In the event of an employee omitting to punch his time at any of the recognised hours, the error would at once be detected by the timekeeper and enquiries made as to the reason, a repetition thereby being prevented. Having thus far seen the part to be performed by the men, our next step will be to follow the clock slip into the time office where the pay-roll sheets are made up. Here again several systems of entering up the pay roll are in force, one of which is to paste the actual clock slips into a book specially ruled for the purpose; but personally I do not think this the best method. I submit in its place therefore a sketch of a pay-roll sheet which has been found to work well, and obviate a lot of duplicate work. (See opposite page.)

In some business places I have visited, the men's time was first entered in a time book, and at the end of the pay period the total number of hours worked by each man was put on the pay-roll sheet. In the sketch shown above you will perceive we have a time book and pay roll all in one. Perhaps someone might ask "Why not paste the actual clock slips in a time book as hinted before?" My idea is that it takes longer to do this than the way I advocate. In the first place, the hours have to be extended on the clock slip. Then this again has to be cut into strips the size of the book and pasted in. Moreover, in the event of a new man starting on the same number as a man who has left during the pay period, there is no room to record the two different names, as naturally to suit the clock slips the spaces between each two numbers are very narrow.

We have now our method of recording the men's time, but in addition to our day workers, there are our piece workers, and although it is interesting and necessary to keep track of their time, yet of course the important part is to keep track of the work performed by them, as it is by this that these men are paid.

In a large manufacturing plant, especially where various lines of castings are made, it is by no means an easy task to keep correct records of the work performed by our piece workers. A plan similar to that outlined hereunder is one I have seen in operation in a large plant, and it has been found to work well. (For the purpose of illustration we will assume that we have no night gang to clear the moulders' floors, and that the castings are cleared first thing the morning after the cast.) On the afternoon of the cast the timekeeper or one of his clerks would go round to each of the molders and core makers and enter up in his rough piece work book the pieces made by the respective men. This piece work book would be ruled after the manner shown on the following page, which for convenience of reproduction within the page limits shows ruling for 10 days only.

As far as the cored work is concerned it is practically impossible for a man to be paid for more than he has made, as obviously the cores would have to balance the number of pieces given in by the moulder, and *vice versa*. On the following morning, the clerk would check up the pieces in the foundry before their removal to the cleaning shop, thus ensuring that he has all his work correctly entered. While doing this he can of course discount any bad pieces which have been made against the workmen responsible for them. As will

BAD CASTINGS											GOOD CASTINGS											
(Date)	1	2	3	4	5	6	7	8	9	10	Description	(Date)	1	2	3	4	5	6	7	8	9	10
											# 52 J. Jones											
	1	1									No 3 Fire Pot		1	2	3							
			6								Bells		8	10	9							
			2								Truck wheels		7	3	1							
											# 16. W. Smith											
		1									No 4 Fire Pot		2	2	2							
											* Division of book											

The Engineering Magazine

FORM OF RULING AND ENTRIES IN ROUGH PIECE-WORK BOOK.

doubtless be observed, this rough piece-work book (see sketch) serves the double purpose of a record for good and bad castings. As soon as this work is completed the clerk can enter up this work on his "fair copy" piece-work sheets—that is, the sheets from which the piece workers are paid. In all probability, too, we shall have day workers in the foundry, and it is necessary that the work performed by these men be not lost sight of, as very often it is these day workers who run up our burden charges. We know from experience that a day worker, generally speaking, does not perform so much work as a piece worker. Again, presuming he turns out defective castings, it is the foundry which has to stand the whole of the loss. For the purpose, then, of keeping such records the day worker should be supplied with a time card on which is indicated the work he is engaged on, and the time he started it. On completion of this particular job he will bring his card to the timekeeper, who will mark on the card the time the job was finished, also extending the cost at the man's rate per hour. By this means we get the actual amount paid for the moulding or core of any casting, which is certainly of great value in compiling our cost records.

So far I have dealt only with the methods of timekeeping and the advantages which accrue from carefulness on the part of the clerk whose duty it is to look after this work. But all this is only a means to an end. Whilst all the information we get from the time cards and piece-work sheets, etc., is very necessary and of great assistance generally, it is incomplete in this state. As I said at the beginning of this article, if we are to know exactly how our wages have been expended we must distribute the monies earned by our employees over the specific jobs on which they have been engaged; then and only then, have we some tangible evidence to go on, which will undoubtedly show us whether we are getting a just return for our expenditure, and also show us where the leakages exist, and enable us to remedy them. This without doubt is the most important thing in any business. We are all more or less aware that these leakages do exist, but to arrange our work so as to be able to spot them at once is of inestimable value to the prosperity of any business. Before we can distribute our pay roll, however, we must have a classification of the accounts* which we wish to keep a line on—that is, a symbol for each of our staple lines of manufacture, and our maintencance charges, etc.

At first sight, perhaps, one might be tempted to imagine that the distribution of a man's time, over the several jobs would be a simple matter, necessitating only the copying off of the charges as turned in on our day-work time cards and piece-work sheets; and apportioning the monies as per our classification. On examination, however, we shall find this to be much more difficult. For instance, the clerk who does this work must necessarily be thoroughly cognisant of the work being done in the shops, and thus be in a position to charge up correctly the hundred-and-one jobs that go through the foundry in the course of a day. Hitherto I have confined myself to speaking of the foundry only, but I think my remarks will be found more or less applicable to the several shops that go to make up our entire works. Our machine shop is in all probability a more complicated shop to deal with than our foundry, as it is here that most of our repairs to plant, patterns, etc., are done. We cannot depend upon workmen to symbolise their particular work correctly on the time cards, and sometimes it happens that they do not even know what the job is that they are working on. In order to illustrate our method of distributing the pay roll, let us classify our shops as follows:— A = Foundry. B = Core Shop. C = Machine Shop. D = Pattern Shop. E = Warehouse, an so on; and let our staple lines of manufacture be classified as follows:— 1, Boilers. 2, Steam Fittings. 3, Jobbing. In addition to these we will have our maintenance charges which we will number thus:— 14. Maintenance of Buildings. 15. Maintenance of Machinery. 16, Maintenance of Tools. 17, General Shop Expense, etc. With this information in mind we will now proceed to distribute the pay roll; and I would commend the method of distributing each man's pay in each shop separately. As you will see by the sketch, along the top line we have the symbols indicating the nature of the work performed by the respective men. At the extreme left of the next lines we enter the numbers of our men as they are known on the pay rolls, and in the balance of the columns we enter up the amount of money expended by each man on each job as per our time cards and piece-work sheets.

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* For a splendid outline of a foundry classification I would refer my readers to the one given by Mr. C. E. Knoeppel, in his articles on Foundry Costing, which appeared in THE ENGINEERING MAGAZINE October, 1908-March, 1909.

GENERAL FOUNDRY DISTRIBUTION OF PAY ROLL, PERIOD ENDING Feb. 1/1910

MAN'S NO.	14A	14B	1	2	3	16C	17D	17E				TOTAL OF MANS PAY
7	1·10	1·05	7·62	1·85	9·27	·45	·22					21·56
8			8·18	22·14	1·10							31·42
9	·15		18·20	2·25	8·10		1·05	·75				30·50
10												
11												

The Engineering Magazine

FORM FOR GENERAL DISTRIBUTION OF FOUNDRY PAY ROLL.

It may possibly be asked "what is the object in having each man's pay separate?" My answer is that by this means it is easy for the distribution clerk to turn up his sheets in case of error, and he is enabled to spot the error at once, without having to go through perhaps hundreds of time cards in order to find the mistake. Moreover, it enables a checker to spot any wrong charges, etc., and if a foreman wishes to know what a certain man has done on any particular job, this information can readily be obtained if a method similar to the one outlined is adopted.

DIRECT CHARGES	1	2	3					
General Foundry	1365.12	776.19	427.86					
Core Shop	781.22	122.15	120.16					
Machine Shop	2211.19	826.41	195.26					
Pattern Shop	200.13	106.15	90.65					
Warehouse	77.16	10.20	1.05					
	[illegible]	[illegible]	[illegible]					

The figures are imaginary

The Engineering Magazine

FORM FOR DISTRIBUTION OF DIRECT CHARGES TO THE SEVERAL SHOPS.

We have now obtained a proper distribution of our pay roll according to the shops in which the men have worked, but we must go a step further to obtain the information as to the amount of money which rightfully belongs to the individual shops—i. e., the amount of direct labour chargeable to each shop, and also its own burden charges. To arrive at these details I would suggest the use of the charts at the foot of page 228 and the one following:—

FOUNDRY BURDEN	A14	A15	A16	A17					
General Foundry	25·15	95·01	7·65	15·81					
Core Shop	5·08	36·22	3·32	2·25					
Machine Shop	16·91	98·17	15·72	13·26					
Pattern Shop	4·72	2·10	3·22	4·09					
Warehouse	1·05	–	2·77	2·50					
Total Foundry Burden	52·91	231·50	32·68	37·91					

The Engineering Magazine

Charts similar to these should be used for each department. By working our charges out on this principle, we arrive at the total amount of our direct charges, and also the amount of burden chargeable to each shop. It does not take much to see of what immense value the figures charted in this way are to us. Primarily they enable us at a glance to notice any undue expenditure on any particular charge. In many manufacturing concerns the upkeep of patterns is no small item, and unless such a department as this is carefully looked after it soon becomes our "graveyard."

Having now our final figures, we can (as you will notice) trace any particular part of them right back to their origin, which I venture to say is a fact worthy of our consideration.

There are, and always will be conditions, prevailing in foundries that must necessarily govern a good many of our actions in costing, yet I trust that this paper will be of interest and helpful at least to some foundry managers and officials. The next article will take up "The Handling of Stores."

A PRACTICAL STUDY OF POWER COSTS.

By William O. Webber.

IT has always been astonishing to me that the power user generally knows so little about the actual cost of his power. This failing seems to be especially common to the management of department stores, although the managers of manufacturing plants in general are nearly as ignorant.

Some time ago, I elaborated a scheme for ascertaining what the costs were in a number of department stores, with suggestions as to the installation of new machinery to reduce the costs of some of the items. I present here a copy of the report which I made at the time, showing the equipment of such a plant, how the actual costs were arrived at, and what they were, with suggestions for the future.

It will be noted that the average cost per car mile for elevators is 29½ cents. Now in another department store in an exactly similar building not a block away from the first example, the cost per car mile for elevators doing similar service was 73 cents, whereas the weight of steam used per horse-power hour on elevators was 43 2/10 pounds in the first instance and 45 5/10 pounds in the second instance. At first sight the difference in cost per car mile seems inexplicable.

In the first instance, the total cost of the elevator system per annum, including interest and depreciation, is $9,022, while in the second instance the total cost was only $4,252. The mystery, therefore, becomes more profound, until we find that in the first instance the total mileage is 27,000 miles, and in the second instance only 5,816 miles. There was then about one-fifth of the mileage in the second instance that there was in the first instance, or a speed of nearly three-quarters of a mile per hour in one instance and three-eighths of a mile per hour in the other instance; there you have the milk in the cocoanut.

The remedy for the case where the elevator cost per car mile is 73 cents is obviously increased mileage; but if there is no demand for this increase of mileage, the only other remedy, (the elevator pump having a capacity of 140 horse power, while only 62½ horse power is demanded), is to compound this elevator pump so as to reduce the cost of its operation. This saving would amount to $604.75 per annum, reducing the cost to a little less than 63 cents per car mile.

It is interesting to note also the similarity in the cost of power per horse-power hour as follows:

Total Horse-Power Hours.	Cost per Horse-Power Hour.
1,234,946	1.9
425,129.3	2.13
885,980	1.86

In this last instance, where the elevator load amounts to 566,060 horse-power hours per annum, the elevator cost per car mile is only 23 cents.

Another interesting point is that these figures show beyond any question the high consumption of coal per horse-power hour, the first plant showing 4.2 pounds, the second 4.55 pounds, and the third 5.25 pounds, without any coal for banking; with banking coal these figures would be 20 per cent higher. The boiler load in the latter case was 310 horse power, which corroborates my power figures.

These several plants show the cost of electric lights, including both incandescent and arc lights, to be 2½ cents per horse-power hour, (or a quarter of a cent per 16-candle-power hour) in one instance; 2.3 cents (equal to 0.23 cents per 16-candle-power hour) in a second instance, and 1.39 cents (equal to three-sixteenths of a cent per lamp) in a third instance. These are particularly interesting in view of the fact that 81,700 16-candle-power lamp hours purchased outside cost $1,037, equal to a cost of 1.27 cents per lamp hour, while electric-light-station data show an average cost per electric horse-power hour of .848 cents, equal to .0848, or a little less than 3/32 of a cent.

The pneumatic cash system cost 1.30 cents per horse-power hour in one instance, and in another case 2.71 cents per horse-power hour; this difference is due largely to the difference in size of plant.

With these figures it is interesting to compare the power costs in a manufacturing establishment, where the lighting load is 2.75 cents per horse-power hour, but the total cost of all the power is 1.24 cents per horse-power hour.

The coal consumption is 3.38 pounds per horse-power hour, and the steam consumption 23.24 pounds per horse-power hour, with a total load of 1,747,108 horse-power hours.

Still further, it is of interest to compare all these figures with the figures recently obtained by me from a gas-producer and gas-engine generating plant, with a total annual load of 534,400 horse-power hours. With coal at $6.00 per ton, the total cost was 1.3 cents per horse-power hour, or about one-eighth of a cent per lamp hour at half load, which would again be equal to 0.83 cent per horse-power hour at full load, so that with coal at the following price we are safely assured of the following cost per horse-power hour at full and half load:

	Cost per Horse-Power Hour, in Cents.	
Cost per Ton.	Full Load.	Half Load.
$1.00	0.462	0.94
2.00	0.537	0.97
3.00	0.600	1.08
4.00	0.680	1.164
5.00	0.75	1.25
6.00	0.828	1.35

Below I give a typical report in detail, showing the data observed, the costs recorded, and the manner in which the results were analyzed:

Date....................

Building corner of Blank and Blank streets, owned by Blank & Company and occupied by Blank & Company as a department store.

BOILER CAPACITIES.

Three Heine boilers, 220 horse power each, or a total of 660 horse power.

Steam pressure, 110 lb. Draft, ¾ inch water.

Grade of coal used—Pocahontas, run of the mine.

Coal consumed—13,800 lb. daily in summer, 19,100 lb. daily in winter. Total coal consumed per year, 2,600 tons.

Average price per ton, $3.00.

Cost of ash removal per year, $303.00.

Boilers are used for supplying steam to twelve elevators, four electric-light engines, three blowing engines, steam pumps and air compressors.

Building is heated by exhaust steam using the Paul system, drips connected to traps and return tank.

ENGINE CAPACITIES.

Four 13 by 12 high-speed Ames engines, 275 revolutions per minute, 125 horse power each, or a total of......500 horse power.

Engines direct-connected to electric-light generators. An average of two of these in use at once. Average..156 horse power.

Three 11 by 12 double, inclined Buckeye engines, 89 revolutions per minute, 60 horse power each, or a total of ....180 horse power.

These engines are direct connected to Root blowers supplying air to pneumatic cash system. An average of two in use....................................116 horse power.

Two 6 by 8 elevator engines, 125 revolutions per minute, 10 horse power each, or a total of.................. 20 horse power.

These engines direct-connected to drum elevators. Average ....15.5 horse power.

One 6 by 9 centre-crank engine..................... 10 horse power.

PUMP CAPACITIES.

Two Davidson elevator pumps 22 by 13 by 22, 65 horse power each, or a total of........................130 horse power.
These pumps furnishing power to nine hydraulic elevators under 115-lb. pressure. Both pumps in use.
Two No. 6 Davidson boiler-feed pumps 10 by 6 by 12, 8 horse power each, or a total of....16 horse power.
One of these pumps in use........................ 8 horse power.
One No. 5 Knowles pump, 6 by 5½ by 7, pumping water for sanitary purposes to tank at top of building...... .64 horse power.
(Fire pumps, etc., only operated on emergency.)

DYNAMO CAPACITIES.

Four General Electric, multipolar type, direct-connected dynamos, 115 volts, maximum capacity 75 kilowatts...400 horse power.
average load ....130 horse power.
Supplying current to electric lights.
One motor, 2 kilowatts, about.......................3.5 horse power
Operating electric elevators for bundles.

ELEVATORS.

Nine hydraulic elevators as follows:—

1	26 -in. cylinder,	7 ft. 8 in. stroke,	gear	10 to 1,	350 ft. per min.
1	24 " "	7 " 8 " "	"	10 " 1,	350 " " "
2	13.5 " "	25 " 6 " "	"	3 " 1,	315 " " "
1	40 " "	6 " 7 " "	"	10 " 1,	350 " " "
1	12.5 " "	25 " 6 " "	"	3 " 1,	218 " " "
1	8.5 " "	10 " 10 " "	piston		350 " " "
2	10.5 " "	26 " 3 " "	gear	2 " 1,	230 " " "

2 direct-acting drum steam elevators, maximum hoisting speed, 150 ft. per minute.
1 electric elevator for bundles.

ELECTRIC LIGHTS.

1,200 16-candle-power incandescent lights.
286 arc lights = 1,710 incandescent lights.
Equal to 2,910 " " = a total of 291 horse power.

AIR COMPRESSORS.

Two Westinghouse air-brake pumps, 16 strokes per minute, 50 lb. pressure, 4 horse power each, or a total of 8 horse power.

ESTIMATE OF POWER USED.

Average boiler power for supplying steam engines....300 horse power.
Average boiler power for supplying steam pumps.......168 horse power.
Average power from engines operating Root blowers...116 horse power.
Average power from engines operating electric light generators ....168 horse power.
Average power from engines operating steam elevators. 13.5 horse power.
Average power required to operate hydraulic elevators 130.8 horse power.

Total elevator load	1628.2 h. p. hrs. per day =	504,742 per annum.
Total electric light load	1310 " " " " =	405,864 " "
Total load of cash system	1044 " " " " =	323,640 " "
Pneumatic pressure load	" " " "	500 " "
Sanitary water "	" " " "	200 " "
		1,234,946 per annum.

OPERATING EXPENSES. PER YEAR.

2,600 tons of coal at $3.00 ton	$7,800.00	
Removing ash	303.00	
		$8,103.00
Engineers and firemen, 52 weeks at $109.	$5,668.00	
Electrical staff = 52 weeks at 60.	3,120.00	
		$8,788.00
Repairs on engines	$50.00	
Water for mechanical purposes, 815,000 cu. ft.	1,002.00	
416 gallons engine oil at 25 cents	104.00	
260 gallons cylinder oil at 42 cents	108.00	
2,000 lbs. of waste at 7½ cents	15.00	
100 lbs. packing at 25 cents	25.00	
5 per cent interest on $36,825 = estimated cost of present plant	1,841.25	
5 per cent depreciation on $30,000	1,500.00	
		$4,645.25
ELECTRIC-LIGHT EXTRAS.		
Repairs on dynamos and motors	$60.00	
Lamps 400 per annum at 18 cents	72.00	
Carbons	1,528.00	
		$1,660.00

Total cost of light, heat and power....................$23,196.25

Total cost of all power used per horse power per hour, 1.88 cents.

Pounds of coal per horse power per hour for total power used... 4.02 lb.

Pounds steam " " " " " " " " " ... 41.8 lb.

ELEVATOR SYSTEM COST.

Total cost of elevator system per annum including interest and depreciation $8,016.00
equal to 1.6 cents per horse-power hour.

Total mileage of elevator system per annum......27,000 miles.

Average cost per car mile..........................29½ cents.

Pounds coal used by elevators per diem..............6,880 lb.

Horse-power hours on elevators per diem ....1,628 horse-power hours.

4.15 lb. of coal per horse-power hour.

Rate of evaporation on boilers......................10.4 to 1.

Pounds steam used per horse-power hour on elevators...43.2 lb.

ELECTRIC LIGHT SYSTEM COST.

Total cost of electric light load per annum, not including carbons consumed in arc lights...............................$10,936.00

Total cost of electric light load per annum, including carbons consumed in arc lights.................................. 12,192.00

Total lamp hours per annum (without carbons), 405,864 = 2.50 cents per horse power hour, or .25 cents per 16-candle-power hour.

Total lamp hours per annum (with carbons), 405,864 = 3. cents per horse power hour.

Total coal per diem.................................5,483 lb.

Electric light load per diem........1,310 horse-power hours =
4.18 lb. coal per horse-power hour and
43.3 lb. steam per horse-power hour.

Cash-System Costs.

Total cost of cash system load per annum $4,515.00
Total horse-power hours = 323,640 = 1.39 cents per horse-power hour.
Total coal used .... 1,080 lbs. per day.
Total load of cash system per day ..... 1,044 horse-power hours.
Remarks:—
Total cu. ft. of space in building 4,000,000
Horse power of steam necessary to heat building 265

NEW INVESTMENT.

Electric-Light Machinery.

Four 3-cylinder 93-kilowatt gas engines installed complete	$20,000.00	
Foundations, piping, etc.	2,000.00	
		$22,000.00

ESTIMATED NEW EXPENSES.

Operating Electric Lights by Gas Engines.

Repairs on engines (four)	$50.00	
Water for engines	20.00	
Oil, waste and supplies	30.00	
Repairs on dynamos	60.00	
Lamps and renewals, 400 at 18 cents	72.00	
Labor—dynamo and electric light man = 52 weeks at $20.00 week	1,040.00	
Depreciation 5 per cent on $20,000.00	1,000.00	
Interest at 5 " " " 22,000.00	1,100.00	
		$3,372.00
405,864 horse-power hours using gas at 1 cent per horse-power hour	$4,058.00	
For incidentals	110.00	
		4,168.00
		$7,440.00

Present cost of electric lights, not including carbons	$10,036.00
New cost of electric lights, etc.	7,440.00
	$2,596.00

Showing a saving on electric lights of $2,596.00
or including interest on value of old steam engines displaced = $200 per annum, the saving in electric lights would be $2,396.00

GENERAL REMARKS.

The present cost of operating the hydraulic elevators equals	$8,016.00	per annum.
together with cash system equal to	4,515.00	" "
	$12,531.00	per annum.

As the steam used for these purposes equals 284 horse power and is just about enough to heat the building, this amount should be equally divided between work done and the heating, so that either of them should be charged with $6,265, and at that low cost it would not be profitable to make a change in the method of operating the elevators and pneumatic system.

It would pay, however, to make the change in generating electric power from steam to direct-connected gas engines, as the steam from these engines is practically in addition to all that is required for steam heating, and therefore the total cost of the steam used in these engines must be charged to the lighting. The difference in favor of generating electric light by gas instead of steam would be $2,396 per year after charging off $2,300 per year for interest and depreciation on the new machinery necessary to utilize the gas, and old engines. I would suggest the replacement of two of the present steam engines direct-connected to generators, by two gas engines of sufficient size, in which case the interest and depreciation amount would only be $1,150 per year instead of $2,300, and a net saving of $3,834 over the present system would be shown; this would be sufficient to furnish all the lights excepting on the very darkest days in the winter, which are also the coldest, and the steam from one of the remaining two electric-light engines would then be partially utilized for heat.

APPLICATION OF LOW-PRESSURE STEAM TURBINES TO COMPRESSOR WORK.

By J. W. Sheperdson.

Mr. Sheperdson's paper is the outcome of some very interesting figures arrived at in a special case. It is valuable as showing the possibilities of increasing the output and efficiency of existing steam plants by the use of low-pressure turbines driving compressors, and it contributes to better knowledge of an important relation of power-plant economy—the relation of the turbine as an adjunct, rather than a competitor, to the reciprocating engine.—THE EDITORS.

IT is today generally admitted that the low-pressure turbine offers a ready means of increasing the efficiency of existing engine plants, especially if concurrently an increase in output is required. Much has been written about low-pressure turbo-generators and their application. Many installations of low-pressure turbo-generators have been completed, tested, and put into successful operation, bringing in their trail very attractive economies. The combination, however, of reciprocating engines with low-pressure turbines as the last expansion stage has not yet reached the point where it is undoubtedly the best policy to pursue in new installations, because the simplicity of the all-turbine steam plant has too many advantages to overbalance the slightly better economy of the combination. The field of the low-pressure turbine will remain for the present in converting inefficient engine plants into economical ones.

The low-pressure turbine as a prime mover can be applied only to machines which can convert mechanical energy of rotation into work. Electric generators have been successfully driven by steam turbines, especially when these generators are electrically locked with the generators of reciprocating machines and when the low-pressure turbine constitutes in effect the last cylinder of the engine. Recently considerable has been written about turbo-air-compressors, and it will be the object of this article to study the application of these machines to this work.

Prior to going into the comparison of the performances of air-compressing plants, it would be well to outline the basis which it is intended to use in the following deductions:—

The ratio of output to input (expressed in the same units) in any machine constitutes its efficiency. The ratio of output of an air compressor, in indicated air horse power, to input in indicated steam horse power, gives the mechanical efficiency of the machine. This efficiency is only a measure of the mechanical losses.

Air compressors are built in multi-stage form with cylinder jackets and inter-coolers, in an effort to approach as nearly as possible isothermal compression, which represents the minimum work. An efficiency based on isothermal compression, therefore, is a measure of all losses and offers a means of comparing different machines on a like basis. As an example, take the air and steam cards of a commercial two-stage compound compressor, shown in Figures 1 and 2.

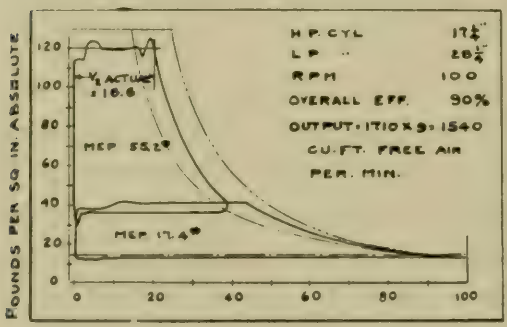

FIG. 1. COMBINED AIR DIAGRAM OF TWO-STAGE COMPRESSOR.

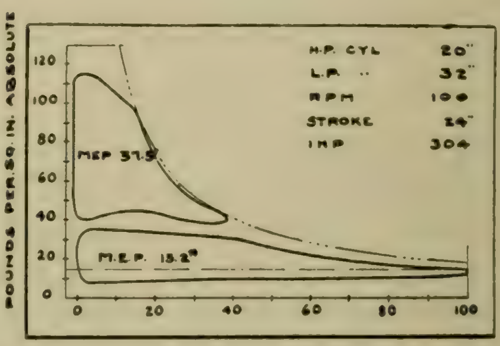

FIG. 2. COMBINED INDICATOR DIAGRAM OF STEAM CYLINDER OF AIR COMPRESSOR.

Calling p_1v_1 and T_1, the pressure, volume and temperature at entrance to compressor, and p_2v_2 and T_2 the same items respectively at discharge of compressor, we can determine any one quantity when the remaining ones are known from the well-known thermo-dynamic equation

$$\frac{p_1v_1}{p_2v_2} = \frac{T_1}{T_2}$$

From observations taken in connection with card in Figure 1 we know that

$p_1 = 14$ lbs. per sq. in. absolute
$v_1 = 100$ volumes.
$T_1 = 501$ deg. F. absolute.*
$p_2 = 120$ lbs. per sq. in. absolute.
$T_2 = 790$ deg. F. absolute.

Substituting these values in the above equation we find

$$v_2 \text{ (calculated)} = \frac{T_2p_1v_1}{p_2T_1} = \frac{790.14.100}{120.501} = 18.5$$

From the card in Figure 1 we find that v_2 (actual) = 16.6; therefore, the volumetric efficiency becomes

$$E_v = \frac{v_2\,(\text{actual})}{v_2\,(\text{calculated})} = 90 \text{ per cent.}$$

This efficiency shows that not all the air taken in on the suction stroke of the first stage is compressed to the final pressure, but that part of it disappears in leaks through stuffing boxes, packing rings, valves, inter-coolers, etc. The displacement of the first-stage cylinder of this particular machine is 1,710 cubic feet per minute at 100 revolutions per minute, and is the free-air capacity of the machine at 100 per cent volumetric efficiency. The output under actual conditions, on the other hand, is 1,710 × .90 = 1,540 cubic feet free-air compressed to 100 pounds gauge.

Figure 3 shows the work of compressing one cubic foot of free standard air, and it will be seen that to compress to 100 pounds gauge isothermally requires 4,350 foot-pounds. Had, therefore, the 1,540 cubic feet per minute been compresed isothermally

$$\frac{4350 \cdot 1540}{33000} = 197.5 \text{ h. p.}$$

would represent the energy expended upon the air.

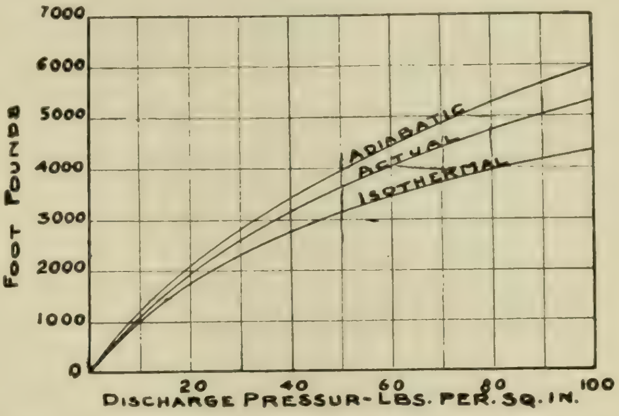

FIG. 3. CURVES SHOWING WORK OF COMPRESSING ONE CUBIC FOOT OF FREE AIR.

The steam cards taken simultaneously and shown in Figure 2 give us 304 indicated horse power in the steam cylinders. The efficiency referred to isothermal, therefore, becomes

$$\frac{197.5}{304} = 65 \text{ per cent}$$

and can be defined as follows:—

Efficiency of a compressor referred to isothermal is the ratio of the theoretically minimum work required to compress the mass of gas actually delivered, to the work actually expended in compressing it.

SOME TEST RESULTS.

Table I shows the condensed data and results of tests made on six commercial compressors, which have been in uninterrupted service for a number of years. The average of these figures can be taken to represent fairly accurately the performance of first-class reciprocating compressors. The steam consumptions given here were estimated by customary methods from the indicator cards, in the absence of means of weighing the condensation.

TABLE I.—TEST RESULTS OF SIX PISTON COMPRESSORS.

Comp. No.	Q_r	H. P. in Steam Cyl.	$\frac{Q_r . W}{33000}$	E_r	w (Condensing)
1	1520	302	200	66.5	3.58
2	1430	294	187	64.2	3.95
3	1510	294	198	67.5	3.71
4	1470	312	194	64.0	3.80
5	1435	291	189	65.0	3.81
6	1510	303	199	65.7	3.56

TABLE II.—TEST RESULTS OF A LOW-PRESSURE TURBO-COMPRESSOR.

Steam Turbine.	Test No. 1	Test No. 2
R. P. M.	3632	3663.5
Avg. Steam Pres. lb. per sq. in. absolute	16.57	17.64
Vacuum referred to 30-in. barometer	28.20	28.27
Hot well temperature deg. F	88.21	90.00
Steam consumption lb. per hr	18960	19331
Turbo-Compressor.		
Temp. of air in suction pipe deg. F	35.25	35.78
Barometer — in. of mercury	30.17	30.17
Free air quantity discharged cu. ft. per min	3742	4373
Free air quantity discharged cu. ft. per min. referred to 30-in. bar. and 60 deg. F	3926	4585
Discharge pres. lb. per sq. in gauge	78.35	79.38
Discharge temp. deg. F	182	192
Cooling Water—lb. per hr	18453	23700
Efficiency.		
Lb. steam per hr. per cu. ft. standard free air per min	4.70	4.216

In a paper read before the German Blast-Furnace Society by C. Regenbogen, and translated and abbreviated in the June, 1909, issue of the *Iron Age*, the author gives performances of turbo-compressors on the testing floor of the factory. In conducting the efficiency tests of these turbo-compressors accurate means were adopted to determine the actual volume displaced by these machines. The steam consumption was determined in the customary way by weighing the condensation from surface condensers. Figure 4 shows characteristic pressure-volume and efficiency curves of a turbo-compressor built for a pressure of 70 pounds gauge.

In the October 27 issue of *Stahl und Eisen* appears an article describing a test of a turbo-compressor on the premises of the purchaser conducted by Prof. Stach. Table II shows the data and results of this test translated into English units. Unfortunately, Prof. Stach does not give the efficiency referred to isothermal. He states in the text of his article that the machines developed practically the same efficiency on the premises of the purchaser, after a period of six months' operation, that they showed at the works of the manufacturer.

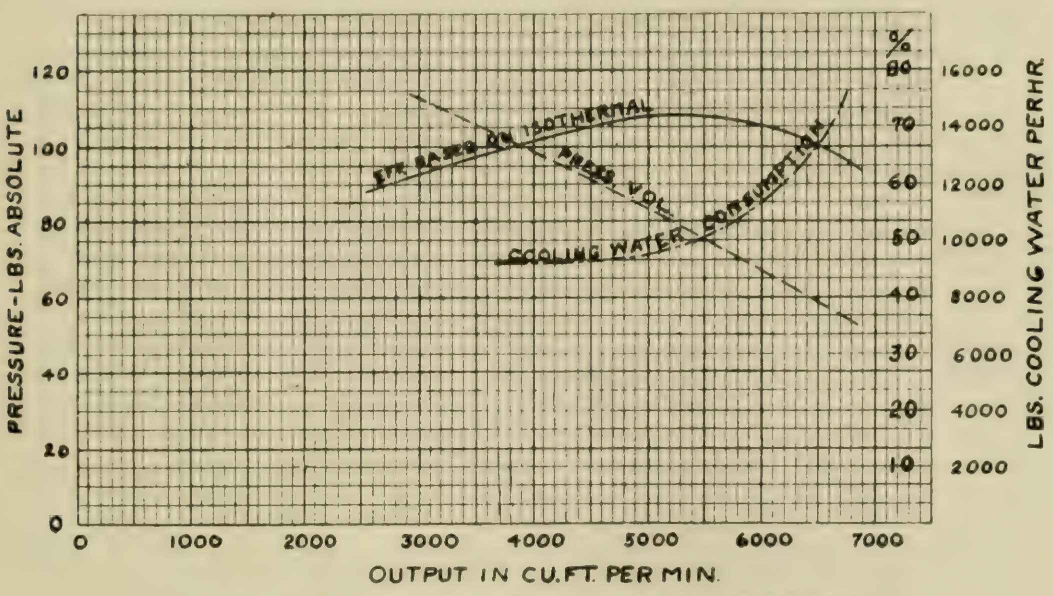

FIG. 4. CHARACTERISTIC CURVES OF TURBO-COMPRESSORS.

The reliability of turbo-compressors as machines suitable for responsible work is illustrated by the fact that the first machine, designed by Prof. Rateau and built in the shops of Sautter and Harlé in Paris, has been in uninterrupted service since 1906. This machine was built in four stages, with inter-coolers between them, and consisted of two separate machines, each having a low-pressure turbine and two-stages of the compressor on its shaft. In addition, one side of the machine was equipped with a high-pressure turbine, so arranged that in the absence of low-pressure steam it could take high-pressure steam and expand it through the low-pressure turbine on the adjoining shaft. This machine delivers 3,180 cubic feet of free air per minute at a discharge pressure of 105 pounds gauge, when running at 5,000 revolutions per minute. Subsequent installations of rotating air compressors for both blast-furnace and Bessemer work have corroborated the first findings, and from the number of representative European firms manufacturing rotary compressors of different types, and the continually growing list of installations, it would seem that they have gained the confidence of both manufacturer and user. With respect to the advantages of high-speed rotating machines over reciprocating compressors, the same arguments hold that led to the replacement of engine-driven generators by turbine-driven ones. The development of compressors for high-pressure work became possible with the advent of high-speed steam turbines and electric motors, with the attending high peripheral velocities on small diameters. All troubles that first had to be overcome in high-speed machines have long ago disappeared, and the rotary compressor entered the field with the experience of the past in its favor.

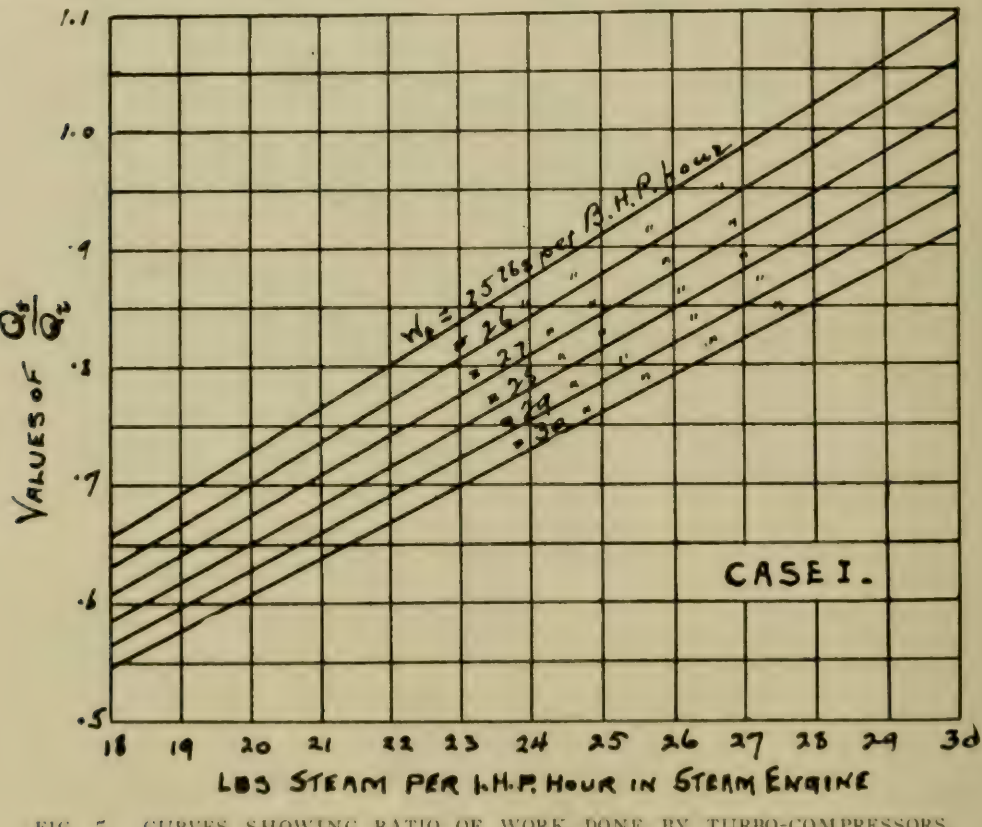

FIG. 5. CURVES SHOWING RATIO OF WORK DONE BY TURBO-COMPRESSORS.

GENERAL CALCULATIONS PERTAINING TO APPLICATION OF LOW-PRESSURE TURBO-COMPRESSORS.

In all applications of low-pressure turbines, a very careful study must be made of the available low-pressure steam in order that the low-pressure turbine be correctly proportioned and operate at the point of its highest efficiency. The output in compressed air energy of the turbine, therefore, is a definite quantity depending upon its water rate and that of the reciprocating compressors.

A low-pressure turbo-compressor can be applied to existing machines in two different ways. Firstly (Case I), the low-pressure turbine can be connected to a rotating compressor which delivers air at the same pressure as the reciprocating machine. Secondly (Case II), it can be made to drive a compressor which delivers its air at a comparatively low pressure to the first stage of the reciprocating machine, thereby increasing its output. These two cases will be considered separately.

Case I.

Calling in the following equations:

Q_r cubic feet of free air compressed per minute by reciprocating machines.
Q_t ditto by turbo-compressor.
w_r and w_t water rates of reciprocating and turbo-compressor respectively.
E_r and E_t efficiency referred to isothermal of reciprocating and turbo-compressor respectively.
W Work of isothermal compression in foot-pounds to any pressure.
f factor representing quality of exhaust from last steam cylinder,

we can write the following equation:—

$$f \frac{W\,Q_r\,w_r}{E_r\,33{,}000} = \frac{W\,Q_t\,w_t}{E_t\,33{,}000}$$

or canceling

$$\frac{Q_t}{Q_r} = f\,\frac{w_r\,E_t}{w_t\,E_r} \qquad (1)$$

Equation (1) shows that the pressure to which the air is compressed has no bearing upon the ratio of work done in the two machines.

Calling Q_r unity in above equation

$$Q_t = f\,\frac{w_r\,E_t}{w_t\,E_r} \qquad (2)$$

Equation (2) expresses the output of the turbo-compressor in percentage of the free-air displacement of the reciprocating machine.

The overall steam consumption "w," expressed in pounds of steam per hour per cubic foot of free air compressed per minute, then becomes (since the only steam consumed is that taken by the steam cylinders of the reciprocating engine):—

$$w = \frac{W\,Q_r\,w_r}{E_r\,33{,}000\,(Q_r - Q_t)}$$

or calling Q_r unity

$$w = \frac{W\, w_r}{E_r\, 33{,}000\, (1 + Q_t)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

From equations (1) and (3) curves in Figures 5 and 6 are plotted for a discharge pressure of 100 pounds, using 4,350 foot-pounds for W from curve in Figure 3, .70 and .65 for E_t and E_r respectively, and .85 for f.

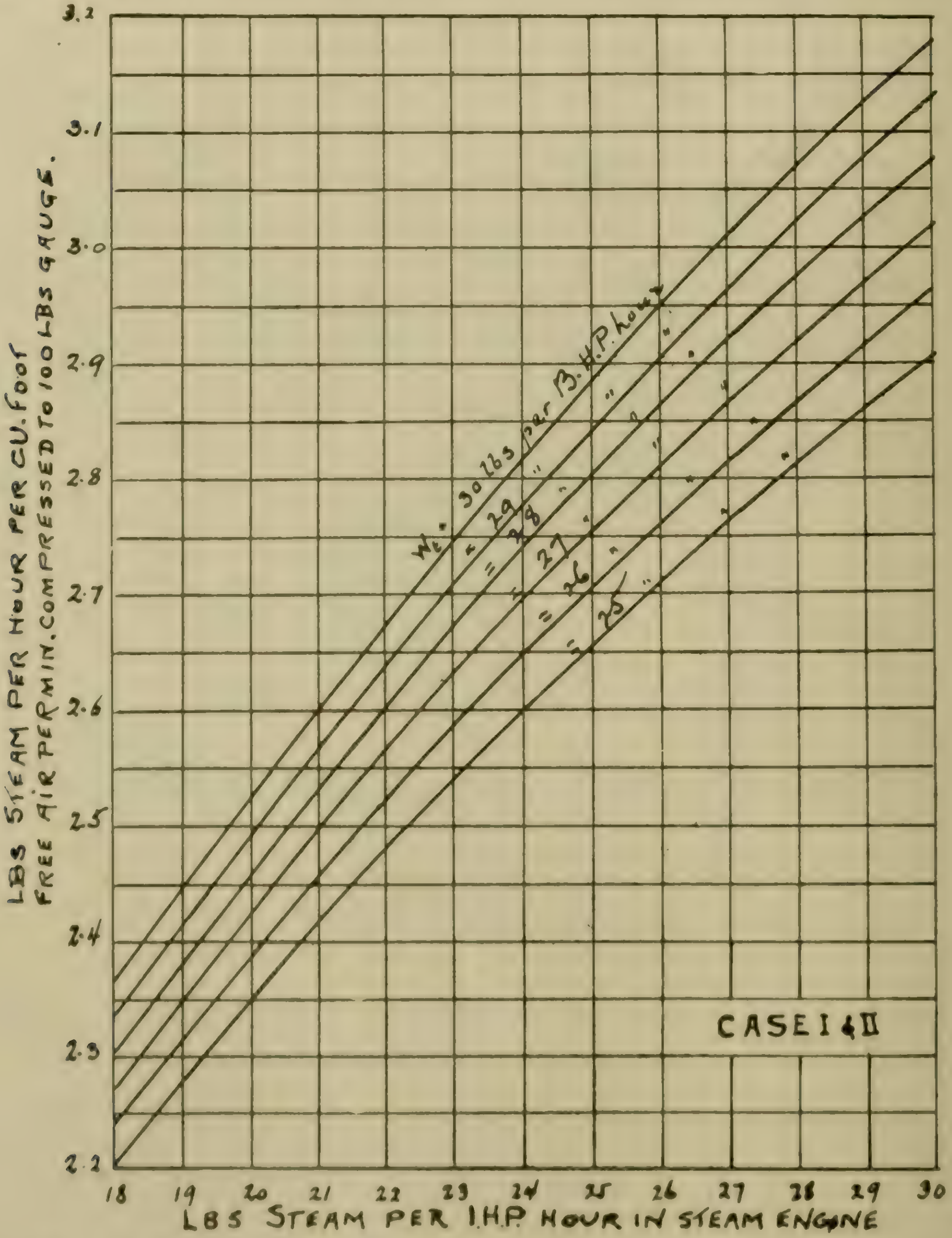

FIG. 6. CURVES SHOWING OVER ALL STEAM CONSUMPTION AT DIFFERENT WATER RATES OF COMPONENT MACHINES.

These curves are developed for the purpose of illustrating the relation between over-all and individual water rates and the ratio of work done in the turbo-compressor. Take for a very ordinary case where $w_r = 22$ pounds per indicated horse power (non-condensing) and $w_t = 27$ pounds per brake horse power, the over-all consumption becomes 2.60 pounds steam per hour per cubic foot of free air compressed to 100 pounds gauge, the turbine compressing 0.74 of the quantity discharged by the reciprocating machine. Under these conditions, therefore, it will be seen that the output of a non-condensing compressor can virtually be doubled by the addition of a low-pressure turbine and a high-grade condenser, without increasing the total steam consumption. The factor f appearing in equations (1) and (2) will vary between .85 and .90, depending upon the quality of the steam supplied, the cylinder ratio, and the cut-off.

CASE II.

Instead of compressing air in the turbo-compressor to a like discharge pressure with that of the piston compressors, this case will consider the turbine as the first stage of the air cycle. Calling—

Q total quantity of standard free air compressed per minute
x the foot-pounds of work referred to isothermal expended per cubic foot of free air by the piston compressors
(W — x) then is the work that the turbo-compressors must do per cubic foot of free air where W is the total work of compression referred to isothermal,

and leaving the remaining designations the same, we can write the following equation:—

$$f \frac{Q\, x\, w_r}{E_r\, 33{,}000} = \frac{Q\,(W - x)\, w_t}{33{,}000\, E_t}$$

or canceling—

$$\frac{f\, x\, w_r}{E_r} = \frac{(W - x)\, w_t}{E_t} \qquad (4)$$

Equation (4) shows that the total quantity of air compressed has no bearing upon the ratio of work done by each machine.

When the discharge pressure is known, W can be determined from the curve in Figure 3 and x calculated by substituting valves for the water rates and efficiencies of the two machines.

Since, again, the only steam used is that supplied to the steam cylinders of the reciprocating machine, the over-all consumption "w" in pounds per hour per cubic foot free air compressed per minute becomes—

$$w = \frac{x\, w_r}{E_r\, 33{,}000} \qquad (5)$$

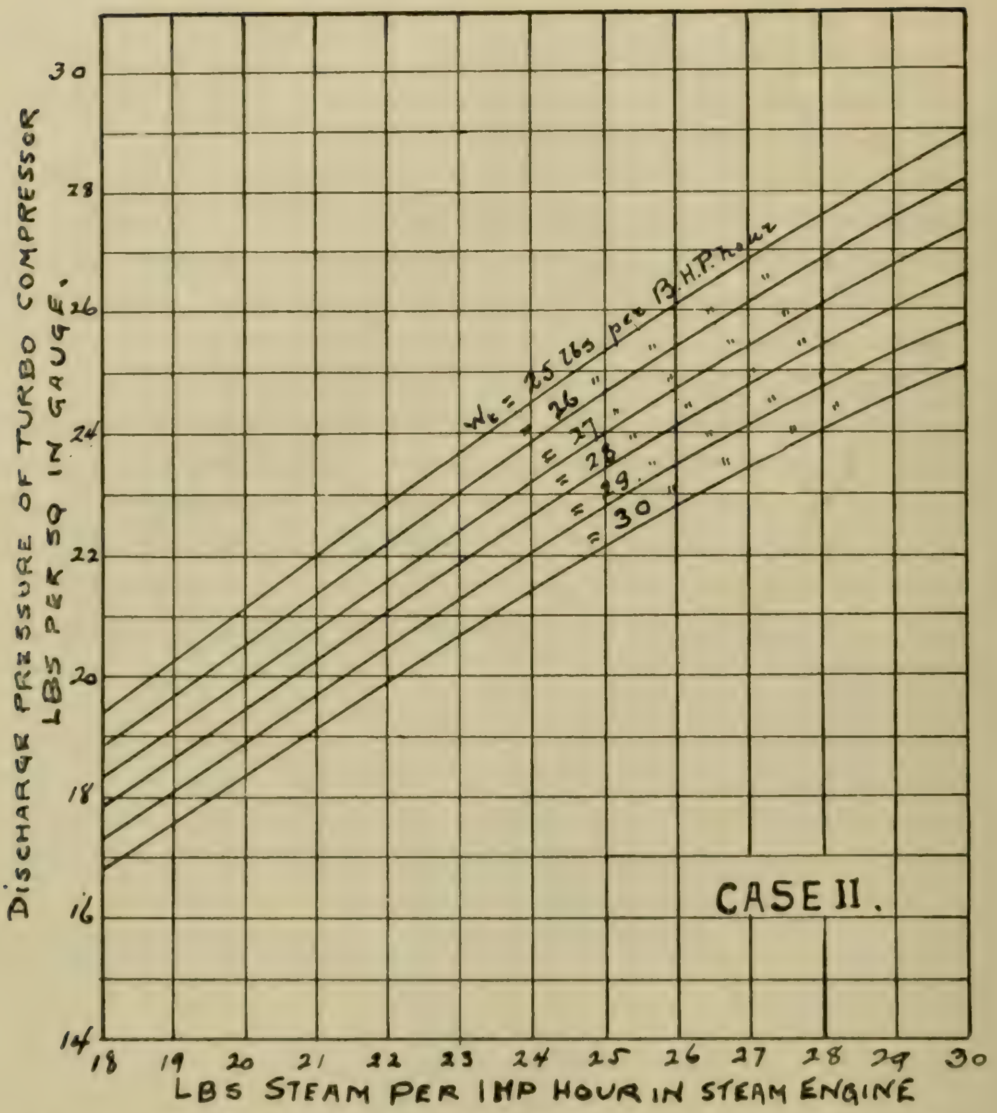

FIG. 7. CURVES SHOWING DISCHARGE PRESSURE OF TURBO-COMPRESSORS.

From equations (4) and (5) curves in Figures 6 and 7 are plotted for a discharge pressure of 100 pounds, using 4.350 foot-pounds for W, .70 and .65 for E_t and E_r respectively and .85 for f.

From these curves we see that for a similar case to the one taken in the first calculation, namely, when $w_t = 27$ and $w_r = 22$—

$$x = 2485$$
$$(W - x) = 4350 - 2485 = 1865$$

Referring to the curve in Figure 3 we see that the turbine must deliver the air to the piston compressors at 21.8 pounds gauge. The over-all water rate from equation (5) under these conditions is 2.60 pounds steam per hour per cubic foot per minute.

These curves show that in order to maintain a balance between the prime movers of the two machines, the discharge pressure of the first compression stage must be a definite amount, depending upon the efficiencies and steam consumptions of the component machines. This pressure will vary from 17 to 29 pounds over the range of performances of machines of this type.

When a combination such as the one outlined above is attempted, it must be borne in mind that slight changes to the reciprocating machines must be made, as in all probability the steam cylinders of commercial compressors will not be equal to the task of compressing a much larger volume of free air to the final pressure, though it be delivered with the compression partly done.

Let us call the normal displacement per minute of the low-pressure air piston Q_r. We know that not all the air taken in on the suction stroke is discharged, but that there is a certain amount of slip. Calling the volumetric efficiency E_v and the efficiency referred to isothermal E_r as above, and the normal displacement Q_r, then the normal power of the steam cylinders can be determined as follows:—

$$\text{Normal horse power of steam cylinder} = \frac{Q_r\,E_v\,W}{E_r\,33{,}000} \ldots\ldots\ldots\ldots\ldots \quad (6)$$

Since the parts of the steam end of the compressor are designed to transmit this energy, it would be unwise to attempt to install larger steam cylinders on existing machines; instead, it would be preferable to decrease the size of the air cylinders. As the piston compressors will now be expending x foot-pounds per cubic foot, the volume of free air that they can now pass through them at normal horse power in steam ends can be seen from the following:—

$$\frac{Q_r\,E_v\,W}{E_r\,33{,}000} = \frac{Q_r\,E_v\,x}{E_r\,33{,}000} \text{ or } \frac{Q}{Q_r} = \frac{W}{x} \ldots\ldots\ldots\ldots\ldots \quad (7)$$

For the condition given in example above $\frac{Q}{Q_r} = 1.74\ Q_r$, or calling Q_r unity, the increase in output due to addition of the low-pressure turbine is .74, or identical with Case I. This, of course, is as it should be, for in these two sets of calculations identical conditions were assumed. This will not be the case in practice, for E_t and E_r will not stay unchanged, regardless of whether the machines are doing complete or partial compression. Since no data are available at this writing, no discrimination was made, but there is reason to believe that a turbo-compressor will exhibit the same slight loss in efficiency at high pressure that the steam turbine does. Likewise, it is believed that, on the other hand, the piston compressor will show a slightly better performance when receiving air at an initial pressure. It would, therefore, be fair to forecast that an arrangement of machines as described in Case II would yield a better over-all economy, based simply on an improvement of the efficiencies of the component machines. If further we consider that three-stage compression offers a better opportunity for inter-cooling, and that the resultant work expended on the air will more closely approach the isothermal line, there would seem no doubt at all as to preference between the two arrangements from the standpoint of economy. Unfortunately, economy is not in all cases the only factor. We must remember that in adopting the three-stage form, changes have to be made to the air cylinders of the piston compressors, firstly in order to stay within the power limits of the steam cylinders, as shown in equation (7), and secondly to re-adjust the ratio of air cylinders, which for 100 pounds pressure and the conditions of our example should conform approximately to the combined theoretical air diagram shown in Figure 8. This change is not costly, and will be off-set by the lower cost of the low-pressure turbo-compressor over the high-pressure one, but the change is in the direction of making the displacement of the piston compressor smaller and hence decreasing its intrinsic ouput, if put on its own resources, should some derangement require the taking out of service of the turbine. Similarly an accident to the piston compressor would make the turbine, with its low delivery pressure, useless. The reliability of the outfit, therefore, is greatly impaired, unless the installed capacity of the plant as a whole is large enough to afford splitting it into groups, with a certain percentage of equipment in reserve. The selection between these two cases must necessarily be guided by the conditions of each individual installation. These calculations were undertaken for the purpose of bringing out the suitability of low-pressure turbines to compressor work and to illustrate a method for developing the possibilities of each individual case.

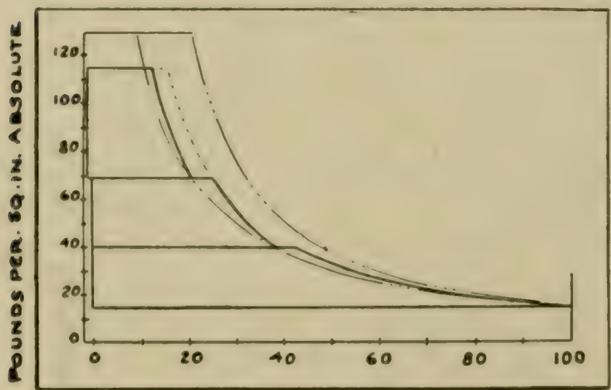

FIG. 8. THEORETICAL AIR DIAGRAM SHOWING THREE-STAGE COMPRESSION.

CONCLUSION.

Many very valuable articles have been written on the principles and theories that govern low-pressure turbine application. It is generally understood that a very careful study of the existing steam engines to which the turbine is to be applied must be undertaken, with a view to determining the steam consumption with relation to steam distribution in the steam cylinders. This takes one into the study of the most economical receiver and back pressure. I believe though an erroneous opinion exists that the water rate of the engine when coupled to a steam turbine has only a small bearing upon the ultimate economy of the combination, because it is believed that the low-pressure turbine will in all cases compensate for poor economy in the engine. A reference to curve in Figure 6 shows plainly the

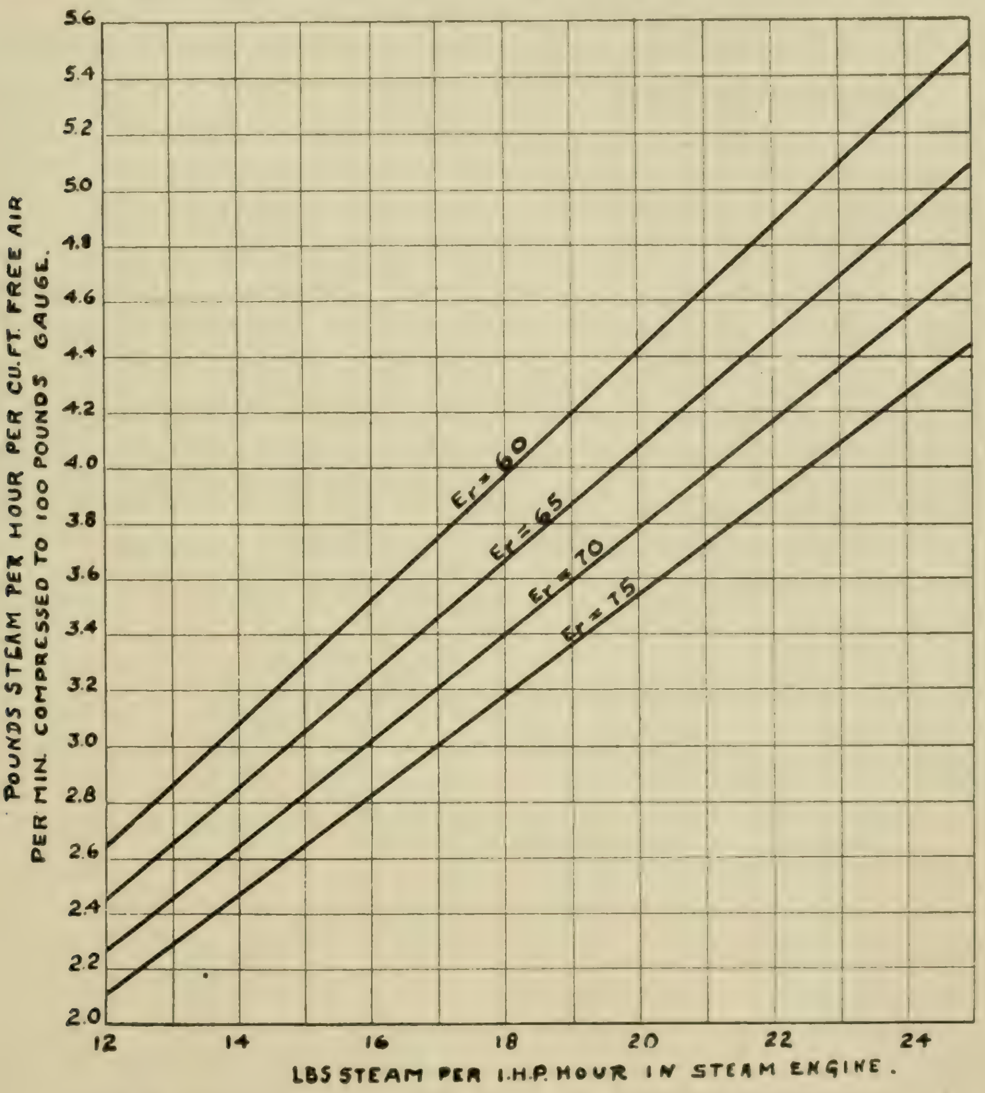

FIG. 9. CURVES SHOWING PERFORMANCE OF PISTON COMPRESSORS.

influence of the water rate of the steam engine upon the over-all performance, and this indicates that as much attention should be paid to adjusting the engine conditions as to proportioning the low-pressure turbine to the available steam at the most suitable initial pressure.

That the addition of low-pressure turbines driving rotating compressors is a judicious policy cannot help but impress itself from the figures and curves presented above. We have seen that the cost in steam ranges from 2.2 to 3.2 pounds per hour per cubic foot of free air per minute compressed to 100 pounds. Curves in Figure 9 show steam consumption per cubic foot of a piston compressor at various water rates and efficiencies. These curves bring out that an economical engine, coupled to an efficient compressor, can deliver air at a steam cost that does not compare unfavorably with the performance of the combination; but when we consider that the addition of a high-grade compressor to an existing plant gives us only a portion of the output economically, while the addition of the turbine adds capacity and improves the economy of the entire output, there would seem to be no doubt in the selection. As stated at the outset of this paper, low-pressure turbines seem inherently adapted to redeem wasteful installations. With the ability to make a turbo-compressor for high pressures and the long established practice in complete-expansion, high-speed steam turbines, there is reason to believe that in the near future we may hope to see modern comprssed-air stations consisting entirely of rotating machines, yielding their output at an economy very close to that of the combined plant without the attending complications of the latter.

EDITORIAL COMMENT

The Science of Industry.

SINCE the decline of the classics a strong tendency has appeared among educators (meaning the administrative heads of colleges and universities) toward the magnification of philosophy and psychology, at some detriment to science, especially applied science. "Philosophy" is indeed so broad a term that it might embrace with catholic affection all branches of learning; but in the university-faculty sense it becomes less comprehensive in scope and less charitable in spirit. This disposition is apparent in the apportionment of the university personnel and the funds. It is unconsciously disclosed in academic procedure and precedents. The highest degree conferred in course is Ph. D.—"philosophy" thus often attaching nominally to her temple the devotee who really belongs to science. The technical school is the Cinderella of the family, pushed backward by the sweeping skirts and chilly shoulders of her older sisters—psychology and philosophy.

Yet what student of mental science, if he would deign to examine so extremely unacademic a subject as industrial engineering, could fail to find in Mr. Gantt's charts, which we publish this month, a most interesting and fertile study in experimental psychology? They provide an intimate revelation of human conduct as controlled by emotions, ideals, and purposes—material for a thesis, better worthy of a degree than many which are accepted by university examiners.

Again, what metaphysician could fail to find, in Harrington Emerson's analysis of the elements and principles of efficiency, that "science of effects by their causes"—that "discovery of fundamental matters"—that "coherent body of theorems"—which constitutes philosophy? His resolution of the conduct of industry into four primary concepts—imaginations, principles, methods and devices; his "dependent sequence" of the twelve elements of efficiency—inspiration or ideals; common sense; expert advice; discipline; the fair deal; reliable, immediate and adequate records; definite standard-practice instructions; dispatching; time study; standardized conditions; standardized operations; efficiency rewards[*]—is there not here the outline of a "science of things evidently deduced from first principles"—in other words, a philosophy?

But alas! The academician still hugs fast a notion from which the aristocrat's hold is partly shaken—the notion that it is a degradation to be "in trade." And it is "in trade," or in industry, that the philosophies of Gantt and Emerson are of inestimable value and promise.

Work on the Isthmus.

AS a headline, the "Original Canal Dug" with which the *Canal Record* introduces its notes of progress in the issue of April 6 is regrettable. It is unfortunate, first, because it is untrue in the sense which will certainly be conveyed to the average reader. The yardage excavated may indeed equal that required by the plans for the "original canal;" but it does not come from within the lines or limits of those plans, and its removal does not accomplish the excavation of a waterway corresponding in position or dimensions to that original canal. There is not, of course, even a distant approach to the completion of any sort of a canal through which vessels can pass. In the public imagination, however, this headline (which is being immediately seized and displayed broadcast by the daily press) will inevitably create a very positive impression that there is now substantially complete a waterway which should be as serviceable as the one planned by the minority of the International Board of Engineers, and later adopted by Congress, and that all the time which will elapse from now until the canal is actually opened is required for the enlargement due to the "changes in plan made subsequently by order of the President."

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[*] This complete development of Mr. Emerson's efficiency practice, covering the tests by which the efficiency of established industries is tried and the steps by which betterment of efficiency is introduced, will be set forth in a series of articles by Harrington Emerson beginning in the issue of THE ENGINEERING MAGAZINE for June next.

This enlargement is nevertheless enormous. In the notes already quoted, it is explained that by Presidential order the total excavation was raised from less than 104,000,000 to nearly 175,000,000 cubic yards. This is an increase of about 70 per cent in excavation alone; and when the locks, dams, and auxiliary features are considered the increase is much greater yet. It is extraordinary, indeed, that while the original plans could be adopted only after years of investigation, study, and deliberation, departures from these plans multiplying the cost to the country should be made autocratically by Presidential order. Under no Administration except that which ended March 4, 1909, is it likely that such legislation under the guise of administration would have been undertaken.

The Briquetting of Fuel.

AN indication of the activity of interest in matters connected with practical conservation of the fuel supply is afforded by the responsive reception that has been given to Mr. Wright's articles on briquetting. As a partial result, certain additional data concerning the state of the art have reached the author and the Magazine too late for inclusion in the body of the article. Among the single-compression machines mentioned by Mr. Wright on page 202 should be included an American model—the Rutledge machine made for the Rutledge & Taylor Co. of St. Louis, and recently installed at their Livingston, Ill., plant. To the Renfrow and Misner presses, mentioned on page 205 as American examples of double-compression presses, should be added the briquette press of the Coal Briquette Machine Co. of Oshkosh, Wisconsin, and among the roll type presses listed on page 208 should be included the Allen press, designed by Charles R. Allen of Oakland, Cal.

The Charles Frederick Chandler Foundation.

THE establishment of the "Charles Frederick Chandler Foundation" by the Alumni of Columbia University is a noteworthy addition to the great scientific institutions of the world—great, not in the mere financial or numerical sense, but in the sense of associating about an enduring centre the personalities and the work of great minds of many generations. It has been created as a testimonial, by Dr. Chandler's old students and associates during a half-century of active work in the University and in professional life. The fund accumulated by their subscriptions (and for the present kept open to other contributors who may wish to participate) will be administered by the trustees of Columbia University. From its income will be defrayed, each year, the expenses of one or more great University lectures by the most distinguished workers in the field which Dr. Chandler has so long cultivated. To their honorarium will be added the Chandler Gold Medal, a replica of the original which was given to Dr. Chandler on the evening of April second. Thus is inaugurated an American counterpart of the Faraday Lectures; and, like them, it will grow continually in dignity and sentiment, and bring year by year a richer tribute to the lasting honor of the name it perpetuates.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

PEAT AS A SOURCE OF CHEMICAL PRODUCTS.

THE APPLICABILITY TO CONDITIONS IN THE UNITED STATES OF PROCESSES FOR THE UTILIZATION OF PEAT SUCCESSFULLY DEVELOPED IN EUROPE.

Charles A. Davis—Economic Geology.

READERS of The Engineering Magazine will recall that in April of last year Charles A. Davis, peat expert of the United States Geological Survey, contributed to our pages an authoritative and comprehensive paper on the peat resources of the United States. In this article Mr. Davis was especially concerned with the importance of peat deposits as a source of fuel supply, the utilization of which would relieve materially the drain upon the coal resources of the country. In round figures, he estimated that the peat bogs of the United States, excluding Alaska, cover an area of 11,200 square miles, and are capable of producing 13 billion tons of dry fuel, which, in the form of machine peat bricks, would be worth $39,000,000,000. If converted into producer gas by the most recent methods, 619,260 billion cubic feet of gas, with a calorific value of 145 B. th. u. per cubic foot, would be available for power purposes. Coked in the by-product coke oven, the 3,609 million tons of coke produced would be worth at charcoal prices $26,000,000,000, and at coke prices $9,744,000,000, and the combustible gases evolved would have a value as fuel of $6,500,000,000.

The value of the chemical products derivable from peat, however, is much greater than the value of the peat as fuel. In the article referred to above, estimates of the values of the various by-products which could be recovered in coking the peat available in the United States reach the enormous total of $86,000,000,000. Being concerned more particularly with the fuel question, however, Mr. Davis made only passing reference to the importance of peat as a source of chemical products. This subject he has discussed at length in *Economic Geology* for January, and we desire in this review to supplement the information as to processes for the utilization of peat we have already given both in these pages and in leading articles with a brief outline of the most recent developments.

The use of peat as a source of certain kinds of chemical products is no new thing. In Northern Europe, where extensive peat deposits have long been a source of fuel supply, peat was distilled in retorts to secure tar and gas as early as the latter part of the eighteenth century. The general awakening to the importance of chemical industries in the middle of the last century led to the establishment in considerable numbers of enterprises based on the conversion of peat into chemical products, but for various reasons they failed to attain commercial success and soon ceased to be operated. These pioneer plants were designed to produce, by the destructive distillation of peat, six materials: (1) sulphate of ammonia; (2) acetate of lime; (3) pyroxylic spirit (wood or methyl alcohol); (4) naphtha (light) petroleum oils; (5) heavy (illuminating) oils; and (6) paraffin (mineral wax). The modern chemist would add to this list but two other substances derivable from peat, namely, asphaltum, and creosote oil and its derivatives. To explain the present commercial success of an industry which had to be abandoned half a century ago, however, he can point to a vast extension of the applications of the various substances derived from peat, and, most important of all, to advances in chemical engineering which have made possible the production at a profit, on a large commercial scale, of chemical substances that formerly could be produced only as matters of experiment in the laboratory.

Progress in the utilization of peat as a source of chemical products has progressed along four well defined lines, each of which is now represented in Europe by a process which seems well within the possibility of commercial success. The four processes, all of which have been brought out within the last twenty years, are: (1) the manufacture of peat coke with recovery of the chemical by-products; (2) the manufacture of producer gas from dry peat with recovery of by-products; (3) the manufacture of producer gas from wet peat in the presence of excess of steam under pressure, with the recovery of the ammonia as ammonium sulphate; and (4) the direct manufacture of ammonium sulphate, acetic acid, acetone, and paraffin by burning wet peat in a special furnace, the chemical compounds secured being the only salable products of the whole series of operations.

The first of these processes, the manufacture of coke or charcoal from peat with recovery of chemical by-products, originated in the early days of peat utilization, when peat was charred in heaps or in cylindrical furnaces by the combustion of part of the charge. The history of the development of by-product coking is too well known to require review. Suffice it to say that the first commercial plant for the conversion of peat into coke with recovery of by-products designed along modern lines was erected at Oldenburg, Germany, in 1894, the invention of Dr. Martin Ziegler. A complete description of the Ziegler process was given in these columns in our February, 1908, number. We shall give here only a few recent test results quoted by Mr. Davis. The peat delivered at the kiln costs $1.19 per metric ton (2,204 pounds). On coking it yields, per ton:

	Pounds.	Value.
Peat coke	775.6	$3.75
Tar	88.2	.52
Wood alcohol	13.2	1.00
Calcium acetate	13.2	.17
Ammonium sulphate	8.8	.21
		$5.65

In addition, gas is produced worth as fuel at least 25 per cent. of the value of the coke.

A four-oven plant treats about 100 tons of air-dried peat each 24 hours. From this amount the following quantities of by-products would be obtained:

	Quantity.	Value.
Ammonium sulphate	900 pounds	$27.63
Calcium acetate	1,320 "	31.02
Methyl alcohol	65 gallons	45.50
Light oils	280 "	21.00
Heavy oils	95 "	7.12
Paraffin	715 pounds	26.81
Creosote oil	3,100 "	66.75
Asphalt	440 "	2.20
		$231.03

Deducting 10 per cent. for sale expenses, the actual value of the by-products would be $208. The total expenses per day are estimated at $308.50, so that the 33 tons of peat coke, the primary product, will cost $100.50 or $3.05 per ton. Increase in plant capacity will not entail a corresponding increase in cost of production, and in a plant three times the size of the one considered the sale of the by-products will nearly or quite pay all expenses, leaving the peat coke as practically all profit. The cost of such a plant is large, however. A plant of four ovens requires a first investment, allowing $60,000 for working capital, of $160,000.

We shall omit all but very brief reference to Mr. Davis' discussion of the second and third processes mentioned above. The Mond by-product gas producer is too well known to require comment, and the Frank and Caro modification of the Mond process was described at length in these pages in THE ENGINEERING MAGAZINE for December, 1907. We may quote, however, Mr. Davis' conclusions as to the utilization of peat in by-product producers. These are: (1)

that peat is considered a good source of producer gas for fuel and power uses in Europe; (2) the recovery of by-products, particularly ammonium sulphate, from gas producers using peat as fuel is not only theoretically possible but is commercially so practicable that large plants using the Frank and Caro process are now reported to be in operation or in the course of development in England, Germany and Italy; and (3) that for small peat gas-producer plants for generating electric or other forms of power, the quantity of ammonium sulphate that can be secured even from peat rich in combined nitrogen by the best processes, while technically entirely possible, would probably not prove commercially successful, since the cost of maintaining a small recovery plant is large when compared with the margin of profit.

Passing now to the process invented by Dr. Herman Woltereck, the last of the four mentioned above, the fundamental proposition of the inventor is that the nitrogen that appears in the ammonia he secured is, in part at least, derived directly from the air, so that he practically makes a synthetic ammonia by fixing atmospheric nitrogen. His process is based on the results of a long series of careful laboratory experiments, which showed that when wet peat is burned at a temperature sufficient to keep the fire going in a specially designed furnace, some of the nitrogen of the moist air forced into the combustion zone induced by the oxidation of the carbon unites with the hydrogen of the organic matter that is being decomposed and forms ammonia. No combustible gases are produced, since the temperature of the fuel bed is always kept below the temperature at which water is decomposed by incandescent carbon (550 degrees C.) and at which carbon dioxide is reduced to carbon monoxide (600 degrees C.); the actual temperature maintained is from 400 to 500 degrees C. But tar, tar water and other distillates are produced in abundance, and from these calcium acetate and paraffin are manufactured.

A plant with a capacity of 5,000 tons of ammonium sulphate per year has been in operation for some months at Carnlough, County Antrim, Ireland. The wet peat is charged into furnaces where it is subjected to moist combustion by means of a blast of air charged with steam. The resulting gases contain paraffin tars, acetic acid and ammonia. The tar is recovered in a bath of heavy petroleum oil heated to 300 degrees C., the acetic acid is recovered as acetate of soda or lime in alkali towers, and the ammonia combines with hot dilute sulphuric acid in acid towers to form sulphate of ammonia, the chief product of the process. The paraffin tar drawn from the scrubber is distilled to drive off the lighter oils; the crude paraffin wax remaining is worth $25 per ton without further purification. The sodium or calcium acetate may be further treated to produce acetic acid or acetone. Woltereck states that the average yield of ammonium sulphate in his experimental plant was 150 pounds per short ton of peat and that yields of 278 pounds have been obtained. His claims for the process are: (1) it gives a much larger recovery of ammonium sulphate than Frank and Caro's process; (2) it permits the use of peat with from 75 to 80 per cent. of water, which is practically as it is dug; (3) it is independent of all other industries, so that the plant can be operated on its own merits, and not on the basis of other and entirely foreign business, as is the case with by-products plants which must be closed when the power plant is not operated; and (4) acetic acid and paraffin enough can be recovered to meet all expenses of digging the peat and burning it, so that the ammonium sulphate worth about $60 per ton will be practically all profit.

What is the possibility of employing any or all of these processes for the utilization of the peat deposits of the United States? Mr. Davis points out early in his paper that with very few minor exceptions there is no overlapping of the areas of occurrence of workable peat and the coal fields of the country; if no other use is made of the peat, there is stored up in it a large amount of fuel in parts of the country where it is needed. Mr. Davis believes, however, that all the processes involving the recovery of chemical products "have commercial possibilities in the United States, if enough capital is available for the construction and maintenance of a plant through the stage of development. Where a market can be had, or is waiting, for peat coke, as in the iron-bearing regions of Michigan, Wisconsin and Minnesota, this should be the primary product, with by-product recovery so far as markets could be found for the material that could be made from the condensible gases. When power can be readily disposed of, producer gas for the generation of electricity is clearly indicated as a means of most successfully using peat deposits, and if the power plant is a large one, by-products recovery will reduce the operating expenses if the heat balance is carefully watched and a proper type of gas producer used, so that the largest possible amount of the valuable ammonia is recovered, as it seems demonstrated that this recovery may be carried on profitably in properly designed large installations. . . . . Finally, it is desirable to have some of the commercially promising processes of chemical manufacture tried under American conditions, so that it may be demonstrated that it is as profitable to use them in the United States as in Europe."

FATAL ACCIDENTS IN AMERICAN METAL MINES.

STATISTICS OF THE FATALITIES IN METAL MINING IN THE UNITED STATES AND CANADA AND A DISCUSSION OF THE NEED OF EFFICIENT LEGISLATION.

Frederick L. Hoffman—Engineering and Mining Journal.

FROM the best data available, Frederick L. Hoffman, statistician of the Prudential Insurance Company, has compiled statistics which disclose the startling fact that the death rate due to accidents in metal mining in the United States and Canada is fully as great as the death rate due to accidents among coal miners. That this unenviable record has not been made apparent before is attributed by Mr. Hoffman, in an article contributed to the *Engineering and Mining Journal* for March 5, to the laxity of the regulations in the majority of the metal-mining States. "Information regarding the occurrence of fatal accidents," he says, "is very limited and of more or less doubtful value. Official returns are available for only a few of the more important metal-mining States. No returns are available for the metal mines of California, Nevada, Utah, Arizona, and a number of other States in which the industry is of sufficient importance to warrant official supervision of mining operations and the official publication of the essential facts regarding the industry." The lack of public interest in mining accidents in these States is severely criticized by Mr. Hoffman, who acknowledges the impossibility, under the circumstances, of compiling an accurate summary of mining fatalities for recent years. He believes, however, that the total of 3,871 accidents reported in the United States and Canada since 1894 considerably understates the actual facts. In all probability not less than 5,000 deaths have occurred during the period 1894-1908.

Mr. Hoffman gives a table showing the ratio of persons killed per 1,000 employed in the metalliferous mines of North America during this period. We quote at length from his analysis of the record. "The table shows that between 1894 and 1908 the fatality rate in the United States have varied from 4.79 per thousand in 1895 to 2.37 per thousand in 8. The rate was as high as 8.28 per thousand in metal mining in Montana in 1896, 7.79 per thousand in iron mining in Dickinson county, Mich., in 1901, and 6.35 per thousand in copper mining in Houghton County, Mich., in 1895; while the rate was as low as 1.45 per thousand for the metal mines of Montana in 1908. The information at present available is not sufficient for a precise differentiation of the accident liability according to the predominating metallic products of the different States. When the returns are combined for the different mining fields and assumed to represent the predominating branch of the mining industry, it would appear that the fatality rate in gold and silver mining as determined by the combined returns for Colorado, Idaho and South Dakota was 2.75 per thousand for the period considered, while the corresponding rate for lead and zinc mining in Missouri was 3 per thousand; for copper mining in Montana, 3.53; for copper mining in Houghton County, Mich., 2.94; and for the iron mines of the same State 4.17 per thousand. Averaging the data for all the States, and for all the years for which the information is available, the fatality rate in metal mining in the United States has been 3.09 per thousand, which compares with 3.13 per thousand for the coal mines of North America during about the corresponding period of time.

"The average fatality rate for the metal mines of Canada during the same period was 3.78 per thousand. The average rate has been as high as 6.64 per thousand for the silver and cobalt mines of Ontario, and as high as 6.54 per thousand for the gold mines of that province. The average rate was lowest for the iron-ore mines of Ontario, or 1.44 per thousand, and as high as 3.57 for the copper and nickel mines of Ontario, and 3.50 per thousand for the copper mines of Newfoundland. The rate has been comparatively low for the iron and pyrites mines of Newfoundland, or 1.93 per thousand, and, while it has been above the average, or 4.23 per thousand, for the metal mines of British Columbia. Some of the extremely high rates for individual years, and particular mining fields, are due to the small number of men employed and do not indicate with accuracy the true occupation hazard of the industry. The information, however, apparently would seem to be sufficiently complete to warrant the conclusion that the average fatality rate in American metal mines, or 3.09 per thousand, is less by as much as 0.69 per thousand, than the corresponding rate for the metal mines of Canada, which is conservatively calculated at 3.78 per thousand.

"It is made apparent by the preceding analysis that the fatal accident liability in metal mining is certainly not much less than the corresponding accident liability in coal mining. It is quite probable that if the subject were thoroughly inquired into, and if all doubtful data were eliminated, it would be shown that the fatal accident liability is really greater in metal mining than the corresponding liability in coal mining. In this connection it has been pointed out by E. T. Corkill, Ontario inspector of mines, that: 'In metalliferous mining an accident seldom occurs in which a considerable number of men are killed, the fatalities usually being one or two at a time, though in the course of a year they may amount to a large total. Public opinion is, therefore, not aroused; the management of the mine is not so much impressed with the importance of careful supervision; the miners are awakened for a few days, and then forget, and the same conditions prevail as before. It is a common belief among most metal miners that the fatalities in coal mines far exceed those in metalliferous mines. This is a great mistake, and, while it is not proposed to argue that metal mining is as hazardous a calling as coal mining, still the writer desires to impress upon all metal miners that only care and close supervision of their work will lessen the number of accidents and place metal mining on the list of the less hazardous occupations.' "

Mr. Hoffman offers for comparison statistics of the fatal-accident rate in the important mining districts of Europe, Asia, Africa and Australia. The rate of the United States is exceeded only by that of the Austrian mines other than iron-ore (3.11 per thousand), the rate for native miners in the Kimberly diamond fields (3.60 per thousand), the rate in the South African Republic (4.56 per thousand), and the rate in the Transvaal gold mines (4.15 per thousand for white, and 4.74 for native, labor). The rate in France is 2.02, in Germany, 1.07; in Italy, 1.73; in the United Kingdom, 1.14; in Tasmania, 1.19; in West Australia, 2.15, in the Queensland gold fields, 1.70, and in the New Zealand gold fields, 1.53 in alluvial workings and 1.32 in quartz workings.

"It requires no further discussion," Mr. Hoffman concludes, "to emphasize the practical importance of a qualified inquiry into the whole subject of fatal accidents in metal mining corresponding to the amount of public attention which is being given to the occurrence of fatalities in coal-mining operations. The same neglect of metalliferous mines is characteristic of English mining legislation, which has never been so effective in the case of metal mines as in that of coal mines. There can be no question of doubt but that a qualified inquiry would bring to light many facts of great practical importance, and there can be no excuse for the derelict mining States of the far West, which at present give no official publicity whatever to the facts of accident occurrence, fatal or otherwise, in the metal mines of the respective States."

THE PROGRESS OF THE ELECTRIC STEEL FURNACE.

RECENT ADDITIONS TO THE LIST OF ELECTRIC STEEL FURNACES THROUGHOUT THE WORLD.

Stahl und Eisen.

IN January of last year we reprinted in these columns from *Stahl und Eisen* a list of electric steel furnace installations in use or under construction in all parts of the world. A new compilation is published in *Stahl und Eisen* for March 23, and in the table below we give a supplementary list, comprising additional installations completed or projected during the last eighteen months. We have included also notes on the more important alterations which should be made in the record as published early last year.

A comparison of the two lists shows some interesting indications of the general tendencies in the development of the electric steel furnace. In the table published last year 78 furnaces were listed, 35 of the induction, and 43 of the

Recent Additions to the List of Electric Steel Furnace Installations in Use or Under Construction in All Parts of the World.

Arc Furnaces.

Héroult.

	Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1.	Gewerkschaft "Deutscher Kaiser", Bruckhausen, Germany	6,000*	Single-phase	800	Charged with cold and molten open-hearth metal. Produces drawn tubes, rails, etc.
2.	Ditto	6,000*	"	800	
3.	Kärntnerische Eisen- und Stahlwerks-Ges., Ferlach, Austria	5,000	"	765	Charged cold. Produces rolled wire.
4.	Brüder Lapp, Rottenmann, Austria	6,000	"	785	Charged cold. Product, dynamo stampings, fine sheets, castings.
5.	Usines Métallurgiques du Hainaut, Couillet, Belgium	5,000*	"	400	Charge, open-hearth metal. Product, castings.
6.	John Allen & Co., Sheffield	2,500*	"	400	Charge, open-hearth metal. Product, tool steel.
7.	Vickers, Sons & Maxim, Sheffield	2,500*	"	...	
8.	Obouchowsche Stahlwerke, St. Petersburg	3,500	"	660	Charge, open-hearth metal. Product for shipbuilding.
9.	Firth-Sterling Steel Co., McKeesport, Pa.	2,500	"	...	Charge, molten open-hearth metal. Product, tool steel.
10.	Ditto	5,000*	"	...	
11.	Illinois Steel Co., South Chicago, Ill.	15,000	Three-phase	2,000	Charge, Bessemer metal. Product, railway material.
12.	American Steel & Wire Co., Worcester, Mass.	15,000*	"	2,000	Charge, Bessemer metal. Product, rolled wire.
13.	Electro Metals, Ltd., Welland, Ontario	500	......	...	
14.	Ditto	5,000*	......	...	
15.	Cia. Mexicana de Acero y Productos Chimicos, Mexico	4,000*	......	...	
16.	Ditto	4,000*	......	...	

Two furnaces, aggregating 10,000 kilograms capacity, reported in the former list as under construction for Georg Fischer, Schaffhausen, Switzerland, are not mentioned in the latter compilation. The equipment of the Firth-Sterling Steel Co. is given in the former list as one furnace of 10,000 kilograms capacity, under construction.

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* Under construction.

GIROD.

Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1. Cie. des Forges et Aciéries Electriques, Paul Girod, Ugine, France	2,000 to 3,000	Single-phase	300 to 400	Charged cold. Product, ordinary and special steels and castings.
2. Gutehoffnungshütte, Oberhausen, Germany	2,000* to 3,000	"	300 to 400	Cold and molten charge. Product, high-quality steel.
3. Stahlwerk Becker, Krefeld	2,000* to 3,000	"	300 to 400	Ditto.
4. Fried. Krupp A.-G., Essen-Ruhr, Germany	10,000* to 12,500	"	...	Ditto.
5. Diosgyörer Kgl. Eisen- und Stahlwerke, Diosgyör, Hungary	2,000*	"	300	Charged cold. Product, high-quality steel.
6. An unnamed American works	500*	"	...	Tool steel.

STASSANO.

1. Leopold Gasser, St. Pölten bei Wien, Austria	1,000	Three-phase	200	Charged cold. Product, steel castings, high-quality steel.
2. Ditto	1,000*	"	200	

None of the seven furnaces of the Forni Termoellettrici Stassano, Turin, Italy, is working, the company being in financial difficulties.

KELLER.

1. Aciéries J. Holtzer, Unieux, France	1,500*	Single-phase	200	Cold and molten charge of open-hearth metal. High-quality and tool steels.
2. Société des Etablissements Keller-Leleux, Livet, France	1,500	"	200	Charged cold. High-quality and special steels and castings.
3. Ditto	3,500	"	450	Ditto.
4. Ditto	200	"	80	Experimental furnace.
5. Luxemburger Bergwerks- und Saarbrücker Eisenhütten A.-G., Saarbrucken	3,500*	"	450	Molten charge from the basic Bessemer converter. Medium-quality rails and structural steel.

The capacity of the first furnace installed at the Aciéries J. Holtzér, Unieux, France, is given in the later compilation as 8,000 kilograms.

CHAPLET.

1. Société des Hauts-Fourneaux et Forges, Allevard, France	5,000	Single-phase	600	Charged cold. Product, ordinary and special steels.
2. Ditto	5,000	"	600	Ditto.
3. Ditto	5,000*	"	600	Ditto.

AKTIEBOLAGET ELEKTROMETALL, LUDVIKA, SWEDEN.

1. A. S. Norsk Elektrometall, Norway	6,000*	Two-phase	736	Molten charge from the electric shaft furnace.

Furnaces of this type are in operation or in course of construction for the production of pig iron as follows: one 400-kilowatt, three-phase furnace with a yearly capacity of 2,500 tons at Domnarfvet, Sweden; two 1,850-kilowatt furnaces with a yearly capacity of 7,500 tons each at the A. S. Norsk Elektrometall, Norway; and one 7,500-ton furnace at Trollhättan, Sweden.

FURNACES DEVELOPED BY INDIVIDUAL FIRMS.

1. A. Hickmann, Staffordshire, England	300	......	...	....
2. Soc. An des Aciéries et Forges, Firminy, France	50	......	...	Experimental furnace.
3. Scott Anderson, Sheffield, England	750	......	...	....

INDUCTION FURNACES.

KJELLIN.

1. Vickers, Sons & Maxim, Sheffield, England	1,500†	Single-phase	230	Charged cold. Product, high-quality steel.
2. Ditto	180†	"	100	Ditto.
3. Wm. Jessop & Sons, Sheffield, England	1,800*	"	250	Ditto.
4. General Electric Company, Schenectady, N. Y.	60	"	50	....
5. Irvington Smelting & Refining Co., Irvington, N. J.	100	"	60	....
6. Electro Metals, Ltd., Welland, Ontario	750	"	150	Charged cold. Product, tool steel.

The following furnaces of this type have disappeared from the list: one 8,500-kilogram furnace at the Röchlingsche Eisen- und Stahlwerke, Völklingen; one at the Allg. Kalziumkarbid-Genossenschaft, Gurtnellen, Switzerland; a 550-kilogram furnace at the works of Vickers, Sons & Maxim; and a 100-kilogram experimental furnace of the Gröndal-Kjellin Co., London.

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* Under construction.
† Not in use.

Röchling-Rodenhauser.

Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1. Röchlingsche Eisen und Stahlwerke, Völklingen	2,000*	Three-phase	275	Molten charge from basic Bessemer converter. High-quality material, rails, etc.
2. Ditto	2,000*	"	275	
3. Pilger & Neidhardt, Frankfurt a. M.	2,000*	Single-phase	275	Charged cold. Produces steel castings.
4. Le Gallais, Metz & Co., Dommeldingen, Germany	3,500*	"	380	Charged with molten pig iron from a mixer. Produces high-quality steel and castings.
5. Aciéries de la Marine et d'Homécourt, St. Chamond, France	3,000*	Three-phase	350	Cold or molten charge. Product, high-quality steel.
6. Kronwerke Zlatooust, Russia	1,000*	"	175	Charged cold. Product, war material.
7. Ricardo Honey, Mexico	2,500*	"	300	Charged with molten pig and ore. Product, high-quality steel.

Two furnaces of this type have disappeared from the list: one 3,500-kilogram furnace at the Röchlingsche Eisen- und Stahlwerke, Germany; and a 1,000-kilogram furnace at the works of J. Knöpfel, Walzenhausen, Switzerland.

Colby.

The single representative of this type has disappeared from the list.

Frick.

Two furnaces of this type, aggregating 4,800 kilograms capacity, have disappeared from the list.

Schneider-Gin.

No longer used.

Hiorth.

No longer used.

Furnaces Developed by Individual Firms.

Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1. Forges de St. Jacques, Montluçon, France	...	......	...	....

COMBINED ARC AND RESISTANCE FURNACES.

Nathusius.

Firm.	Capacity, kilograms.	Current.	Power requirements, kilowatts.	Remarks.
1. Oberschlesische Eisenbahn-Bedarfs A.-G., Friedenshütte, Germany	5,000	Three-phase	750	Charge, molten Bessemer or open-hearth metal. For soft and hard steels.
2. Ditto	1,000	"	250	Charge, solid or molten basic open-hearth metal. For experimental work.

* Under construction.

arc, type, with a total capacity of about 210,000 kilograms. The present compilation lists 114 furnaces, an increase in number of about 46 per cent., with a total capacity of about 356,000 kilograms, an increase in capacity of over 66 per cent. The greater percentage increase in capacity than in number results from the increase in capacity of the individual units, which is noticeable throughout the list.

The number of induction furnaces listed remains the same as before, notwithstanding the development of the Röchling-Rodenhauser furnace. The total capacity of the induction furnaces, however, has decreased from 85,000 to 77,000 kilograms. On the other hand, the total capacity of the arc furnaces, 77 of which are listed in the present compilation, has increased from 125,000 to 273,000 kilograms. A new type of furnace, the combined arc and resistance type, is represented in the present list by two units, with a combined capacity of 6,000 kilograms.

Type.	In operation.	Not working.	Under construction.	Total.
Chaplet	4	..	1	5
A. G. Elektrometall	2	..	2	4
Soc. An. in Firminy	1	..	..	1
Frick	1	..	..	1
Kjellin	10	2	2	14
Kjellin-Colby	2	..	..	2
Röchling-Rodenhauser	6	1	8	15
Girod	9	..	8	17
Héroult	17	..	12	29
Hickmann	1	..	..	1
Hiorth	..	1	..	1
Keller	4	..	2	6
Forges et Aciéries in Montlucon	1	..	..	1
Nathusius	2	..	..	2
Schneider	1	..	..	1
Scott Anderson	1	..	..	1
Stassano	5	7	1	13
Totals	67	11	36	114

In the table above is summarized the information given regarding the number of units of each type of furnace in operation, idle, and building.

POWER DEVELOPMENT ON THE LOS ANGELES AQUEDUCT.

A PRELIMINARY REPORT ON THE POWER AVAILABLE, THE COST OF DEVELOPMENT AND THE PRACTICABILITY OF THE SCHEME.

Engineering News.

ELECTRIC-power development has always been one of the most attractive financial features of the Los Angeles aqueduct project, a description of which was contributed by Burt A. Heinly to THE ENGINEERING MAGAZINE for November, 1909. The bond issue of $23,000,000 in June, 1907, unfortunately exhausted the bonding power of the city without providing funds more than sufficient for the construction of the water-supply aqueduct alone. The finances of the city now make it possible, however, to issue more bonds. Approximately $400,000 can be saved in aqueduct construction through San Francisquito Canyon if power development is undertaken at the same time, and this consideration, coupled with the desire of the city to have the project on a paying basis as soon as possible, is responsible for a by-law authorizing an additional bond issue of $3,500,000 which will have been submitted to the people of Los Angeles before this review appears. At the time of writing there seems to be practically no opposition to the issue of the bonds, and it is now expected that one or more of the power houses will be in operation upon the completion of the aqueduct in December, 1912.

In December last three prominent electrical engineers were constituted a Board to make a preliminary investigation of the power output of the aqueduct. Before summarizing the findings of this Board, after their report to the Los Angeles Water Board, reprinted in full in *Engineering News* for March 24, we may refer briefly to the estimates of the first Board of Consulting Engineers who reported late in 1906. They found three localities along the line of the aqueduct where a surplus fall could be utilized for the generation of power. The most important of these was near Elizabeth Lake, about 45 miles from Los Angeles, where they found a fall of nearly 1,500 feet. It was recommended that this fall be developed by two stations working under heads of 1,060 and 415 feet respectively. A third site was found not far below the end of the aqueduct in the San Fernando valley, where a head of 215 feet could be secured, and the fourth was located near Little Lake, about 150 miles from Los Angeles, where a net fall of 270 feet could be made available. The first Board estimated the maximum power output at 93,000 horse power, to accommodate a load factor on the Los Angeles substation of 40 per cent.

The later Board find seven power sites along the line of the aqueduct and its feeders. These are enumerated in the following table:

Location.	Distance from Los Angeles, miles.	Continuous capacity, kilowatts.
Fernando	24	7,250
San Francisquito, No. 2	40	32,000*
San Francisquito, No. 1	47	51,750*
Haiwee	162	4,500
Cottonwood, No. 1....	185	1,500
Cottonwood, No. 2....	185	2,500
Division Creek........	225	600

* Peak capacity.

The Board report that "the general plan of the development of electric power along the line of the aqueduct and its transmission to Los Angeles and vicinity is a thoroughly practicable scheme, involving no engineering problems which should not permit of successful solution, and promising a reliable source of power which should find a ready market at prices advantageous to the city. . . . The total amount of power which can be delivered in the vicinity of Los Angeles and ready for sale at step-down voltage is approximately 1,152,000 kilowatt-hours per day, corresponding to a uniform delivery of 48,000 kilowatts or 64,000 horse power for 24 hours, or to a maximum delivery of 90,000 kilowatts or 120,000 horse power on a load curve of form corresponding to the average conditions in and about Los Angeles at the present time and of which the average load is 53 per cent. of the maximum." This estimate of the power available is approximately 30 per cent. in excess of the estimate of the first Board of Consulting Engineers. The difference is explained by the facts that the later estimate includes 4,500 kilowatts available at Cottonwood and Division Creeks, the development of which was not contemplated by the first Board, and that the final surveys for the location of power sites have shown the possibility of obtaining higher heads than were considered by the first Board without increase of cost of aqueduct construction.

The installation cost for the development and transmission of the power, ready for sale at step-down voltage at Los Angeles, based on a peak-load capacity of 90,000 kilowatts or 120,000 horse power, is estimated by the Board at $80 per kilowatt or $60 per horse power. Many conditions combine to justify this estimate, which is markedly lower than the average cost of hydraulic-power development and installation elsewhere on the Pacific coast and under generally similar physical conditions and surroundings. Among the more important considerations may be mentioned these five: (1) the primary diversion works are a part of the aqueduct project, and the water is carried along the aqueduct line in close proximity to the power site; (2) the principal power sites are relatively close to Los Angeles and are relatively accessible for the transportation and installation of equipment; (3) the power sites offer no severe conditions for engineering construction; (4) sufficient time is available for a complete investigation of the actual conditions at the various sites and for the careful preparation of plans in advance of undertaking the work of construction; and (5) the construction work will profit by the experience gained in like work on the main aqueduct and by the efficient organization developed in the course of its construction.

The plan of development assumes that, under ordinary conditions, "the average aqueduct flow per day will be at the rate of 400 cubic feet per second, and that this flow must be maintained, or at least permitted, whether power is developed or not. With this steady flow the capacity of the power sites at San Fernando and at the Haiwee Dam together with those at the Cottonwood and Division Creek feeders, with average stream flow of 20 second-feet and 8 second-feet, respectively, will provide for a steady development of some 14,000 kilowatts, which is expected to represent, under full development, substantially the minimum demand occurring in the early morning hours. Superimposed upon this uniform output of 14,000 kilowatts, sustained by these steady-flow plants, the amount of power required to accommodate the variable demand throughout the day must vary from nothing to some 76,000 kilowatts. This demand taken in conjunction with the existing heads at the two power sites in San Francisquito Canyon will require a flow of water varying from nothing up to 1,000 second-feet, while at the same time the total amount passed per day must correspond to an average flow of 400 second-feet, as in other parts of the aqueduct. To provide for this variable flow at these sites while at the same time insuring the necessary continuous daily average flow throughout the entire length of the aqueduct, provision is made for adequate storage reservoirs above and below these sites. The function of these reservoirs will therefore be to permit of the regulation of supply in accordance with the demand, while in addition they will have a capacity sufficient to provide a guarantee against interruption of service due to accidents or repairs on the aqueduct line between the Fairmont and Haiwee Reservoirs. These arrangements will effectively provide for the close adjustment of power output to demand, and within the capacities above stated should obviate the necessity of any steam plant for relay or for carrying peak loads."

The total daily energy delivered to the city will be transmitted over the moderate average distance of 65 miles, while the corresponding average distance for the energy at the time of maximum power demand will be 55 miles. An aggregate of 9,200 kilowatts will be generated continuously at points that are 162, 185, and 225 miles from the city. Special facilities for controlling the power factor and regulating the terminal voltage such as are usually necessary in transmission over such distances, will not be required. The stations near the city will perform the duty of regulating the distant power sources, with a corresponding increase in reliability, effectiveness and economy. The conditions are favorable for low operating cost. Besides the conditions making for reliability of service already enumerated, the expectation of low operating expense is justified by the lack of need of steam auxiliaries, the reduction in superintendence and labor charges by the development of 70 per cent. of the power in two large blocks of about 46,000 and 30,000 kilowatts respectively, and the relatively close proximity of the main blocks of power to the city of Los Angeles.

The Board recommend a progressive development of the power at such a rate as the growth of the power market may justify. They point out that the demands of the aqueduct project itself will require certain items of installation at the power sites for simply passing the water. To avoid the additional cost of temporary constructions, they recommend as a first step the installation of such portions of the equipment as may be required for this purpose for the aqueduct project itself, together with the full development of one or more power sites as further study may indicate. The proposed bond issue of $3,500,000 they consider well suited to the probable demands of the first step of the power-development programme.

INTERNATIONAL STANDARDIZATION OF ELECTRICAL UNITS.

A BRIEF ACCOUNT OF AN INTERNATIONAL CO-OPERATIVE INVESTIGATION NOW IN PROGRESS AT THE BUREAU OF STANDARDS, WASHINGTON.

Edward B. Rosa—Electrical World.

A GROUP of five physicists, representing the national standardizing institutions of England, Germany, France and the United States, are now engaged, in the laboratories of the Bureau of Standards, in Washington, in an international co-operative investigation on electrical standards. The International Electrical Conference, which met in London in October, 1908, passed certain resolutions with regard to electrical units and standards, but left to an International Committee, comprising representatives of eleven different countries, the duty of completing the specifications for the concrete electrical standards and of deciding upon a new numerical value for the Weston "Normal" cell which could be adopted internationally. The investigation begun in Washington on April 1 last is in discharge of this duty. We take a few data of the scope and methods of the inquiry from an article by Edward B. Rosa in *Electrical World* for April 7.

"As is well known, the value for the Clark standard cell (1.434 volts at 15 degrees C.), which was adopted by the Chicago Electrical Congress in 1893, was not accepted by Germany. After further experimental investigations, Germany adopted the value, 1.4328 volts at 15 degrees C. England, America, France and some other countries have followed the Chicago Congress, whereas other countries have followed Germany, and hence there have been two different values for the volt in use.

"In course of time, the method of preparation of the Clark cell was improved so that the cell became more reliable, but at the same time its electromotive force was slightly altered. At the Bureau of Standards, an allowance was made for the change in the electromotive force of the Clark cell, so as to preserve the unit of electromotive force unaltered. In England, however, the original numerical value was retained in spite of the fact that the new cells had slightly different values from the old. The result was that a discrepancy arose between the values in use in England and America. Hence, there were and still are three different volts in use in different countries. The Weston Normal cell, officially adopted at the London conference in place of the Clark cell, has the following values: In America, 1.0189 at 25 degrees, equivalent to

1.019125 volts at 20 degrees; in Germany, 1.0186 volts at 20 degrees; in England, 1.0184 volts at 20 degrees. Some of the other countries have the same value as America, others the same as Germany. England adopted the last named value only one year ago, and no other country, as far as known, has followed its example.

"The London Conference of 1908 adopted the ohm as represented by the resistance of a specified column of mercury, and the ampere as represented by a certain mass of silver deposited in a silver voltameter, as the two independent fundamental electrical units, and declared that the value of the volt should be derived from these two. The electrochemical equivalent of silver adopted at London was 1.11800 milligrams of silver per second per ampere of current. It was known that different investigators had obtained different values for the electrochemical equivalent of silver, according to the kind of voltameter used and the methods of preparing the silver nitrate, so that the international committee found itself confronted with the problem of preparing specifications for the voltameter, when there was a great difference of opinion as to the proper procedure and as to the true value of the electrochemical equivalent of silver, which had, however, been definitely fixed by the conference. . . .

"It was impossible to select a new value of the Weston Normal cell in terms of the ohm and the ampere until the latter should be more precisely defined than had been done by the London Conference. Correspondence among the members of the committee who were connected with national standardizing institutions seemed to indicate that it would be impossible to agree upon the specifications of the silver voltameter without further investigation, and it was proposed by the American members of the committee that a joint investigation to clear up, as far as possible, outstanding problems on the standard cell and the silver voltameter be arranged with representatives of several of the national standardizing laboratories as participants. Prof. S. W. Stratton, in his capacity as director of the Bureau of Standards, offered the facilities of the Bureau of Standards for an international investigation, and in his capacity as treasurer of the international committee, offered to secure the funds to pay the expenses of the investigation." The work now in progress in Washington is the result of his efforts.

"In addition to the work on standard cells and the silver voltameter, a comparison is to be made of the resistance standards of the several national standardizing institutions. The wire standards of the Reichsanstalt, the National Physical Laboratory and the Bureau of Standards differed only about two parts in a hundred thousand at the last intercomparison about a year ago, the standards of the first two of the above institutions having been fixed independently by legally specified mercury ohms. It is expected that a common value of the international ohm will be agreed upon so that no difference greater than one part in a hundred thousand will exist between the wire standards of the national standardizing institutions.

"It is confidently expected that the committee will succeed in coming to a satisfactory agreement with respect to the official specifications of the silver voltameter and the Weston Normal cell, and will be able to agree upon a value for the latter which can be recommended to all countries of the world for adoption. The degree of accuracy which is now obtainable in electrical measurements, both in absolute measurements and in relative measurements, far surpasses what was possible in 1893, and indeed has increased greatly within the last five years. There is reason to believe that values adopted now will be satisfactory for a generation at least without change. The European delegates have brought with them, from their own laboratories, a quantity of apparatus and chemicals in order that they may reproduce work done in their own laboratories at the Bureau of Standards, as accurately as possible. The Bureau of Standards has provided every facility for carrying on the work expeditiously and with the highest precision." It is hoped that it will be completed within another month.

THE WEIGHT OF SHIPS' CARGOES.

A NEW METHOD OF ASCERTAINING THE WEIGHT OF CARGOES ON BOARD SHIP.

A. Murray—Institution of Naval Architects.

DURING the last few months numerous references have been made in technical journals more exclusively devoted to marine and naval engineering to an invention known as the "Porhydrometer," a device for weighing cargoes on board ship. The invention of an Italian, the device was first installed in an Italian vessel. The results of the first experiments with this full-size installation were so satisfactory that the Italian government became interested and undertook a series of exhaustive tests. The "Porhydrometer" is now recognized by the Italian government as an official weighing machine, and a clause has been embodied in the customs regulations to the effect that the weight of cargo registered by the device shall be accepted as correct by the customs authorities.

We quote at length below from an authoritative description of the "Porhydrometer," communicated by Alexander Murray to the Institution of Naval Architects at the recent annual meeting. "One of the greatest sources of loss to shipowners and shippers," he says, "arises out of the claims for shortages in cargoes, not to mention the inferior weight which is often delivered to vessels taking in bunker coal. Especially in cargoes such as coal, iron ore, grain, etc., which are carried on weight tonnage rates, the losses sometimes are very serious, as even the allowance of 2 per cent. granted in view of weighing a coal cargo often fails to eliminate discontent. The methods of control at present in use are certainly not satisfactory. The taking of draughts and applying the readings to the ordinary displacement scale can hardly be said to be accurate, as it is difficult to measure the draught to within an inch, which may mean an error of about 45 tons, in a 10,000-ton deadweight vessel, and, besides that, there is an error dependent on the varying density of the water in which the vessel is floating. The displacement scale itself is generally calculated from a small-scale drawing, and may also show inaccuracies. With internal draught tubes the errors due to density are not corrected. In most cases the weights declared by the shipper have to be accepted, as the owner, without going to the very great expense of reweighing, is almost powerless, although satisfied in his own mind that he is not being fairly treated.

"After considerable study and experiments, Signor Emilio de Lorenzi, of Genoa, has invented a novel appliance called the 'Porhydrometer,' to overcome these difficulties. The fundamental principles utilised are:—First, that a body floating in a liquid will displace an amount of that liquid equal to its own weight; second, the hydrostatic balance —viz., that the level of liquid in two connected cisterns will be equal if the density or specific gravity is equal, and if the density be different the surface level will vary in exact proportion to the density.

"The method adopted in practice may be described as follows:—Inside the vessel is placed a vertical tube which forms the measuring cistern. This tube is fitted with a water connection, consisting of a small pipe and a valve or sea cock, leading to a point permanently submerged when the vessel is afloat. Thus the water in which the vessel is floating has free access to the vertical tube and rises in it to the same level as outside. Should the water in the tube, through any cause, be of a greater or less density than that in which the vessel is floating, its level will automatically adjust itself higher or lower in proportion to the head measured from the lowest point of the connection.

"The aerometer, which is the chief part of the instrument, is suspended in position inside the vertical tube, and is always partly immersed. The aerometer can probably best be described as a float, although in reality it is made heavier than the water it displaces, and has a varying tendency to sink. As the vessel is pressed down in the water by cargo, or by any additional weight placed on board, the water rises relatively in the tube and the aerometer is increasingly immersed. The difference of displacement thus caused by the aerometer will reduce its tendency to sink, or the constant downward pull which it exerts. This varying downward pull is measured by an ordinary weighing machine on which the readings are made to correspond to the weight placed on board the ship.

"In some of the earliest instruments designed, the aerometer was made parallel, giving a regularly increasing or diminishing measure of displacement, and the scale on the weighing machine was made to vary as the carrying power of the vessel increased at the deeper draughts. For various reasons this has not been found thoroughly satisfactory, and the weighing machines are now made to standard patterns, with evenly divided scales, which can be easily tested both independently and with the whole apparatus complete, and which fulfil satisfactorily the Board of Trade requirements. The variation of carrying power of the vessel is accounted for in the construction of the aerometer, which, to all intents and purposes, is a theoretical model of the vessel for which it is made. The sectional areas of the aerometer are now made at each and every draught of water to bear exactly the same proportion to the corresponding waterline areas at the same draughts. The form of the aerometer is, therefore, an inverted cone, and its areas, if set up in the form of a curve, will be found very closely to assimilate the curve of tons per inch immersion of the vessel. The areas of the vessel and her aerometer being mechanically fixed, proportionate quantities, and the variations of draught (the multiplier for the displacement cube) being equal and of full natural size in both cases, very great accuracy is attained, and even an exceedingly small alteration in the height of water in the vertical tube will affect the balance of the steelyard. In cases where the correct data for calculating the aerometer are not available, the areas are obtained by simple experiments. A test aerometer of exactly parallel form and known sectional area is inserted, and at various draughts, during the ordinary course of loading the vessel, known weights are placed on board and readings taken on the machine. The correct areas sought for those draughts will then be in proportion to the areas of the test aerometer as the known weights are to the readings. If several such tests are made a curve can easily be set off giving the correct form and size.

"In most cases the weighing machine is fitted with an intermediate lever and counterweight, but the arrangement can be varied to suit the circumstances on board the vessel, and connections made by tension wire or levers. In some smaller installations the aerometer is attached directly to the steelyard; the steelyard in this case must be of the reversed type.

"To overcome errors due to inclination and change of trim, it is necessary to have the measuring part of the apparatus, or aerometer, in the centre of the vessel, both transversely and longitudinally. Transversely this is easily found, and within the ordinary range of inclination no error is perceptible. Longitudinally, however, it is more difficult, as the point sought for is seldom the exact centre of length; what is wanted is the point of intersection of the horizontal normal waterlines with the altered trim waterline. This is approximately the centre of waterline area, and is the point at which the most accurate mean draught can be taken. In cases where the desired position is not available, two tubes opposite and equidistant from that point are fitted and their aerometers united in the manner of a double bogie weighing machine. For excessive changes of trim, such as when the bows are completely out of the water and the overhang of the counter is immersed, the increased waterline area will decrease the depth and cause a difference.

"Further, the steelyard, which by its very nature is a level indicator, must have an adjustment to bring the fixed indicating point to the level position. This is done by placing a spirit level in the base of the machine and hinging the base around the point of attachment to the rest of the apparatus. It is leveled by a screw.

"The 'Porhydrometer' controls accurately the weights between any light waterline and the full load. It is difficult, if not impossible, especially in large vessels, to establish the exact point at which the ship may be called light, and consequently the machines are generally adjusted to register from a zero somewhat below the probable light draught line; thus a constant tare exists. When weighing either out or in, two readings must always be taken, the difference being the actual load added or removed. The accuracy of a porhydrometer can be tested at any time by placing comparatively small known weights on board the ship."

THE REFORESTATION OF RESERVOIR LANDS.

A SUMMARY OF THE COST OF REFORESTING THE MARGINAL LANDS OF THE WACHUSETT RESERVOIR OF THE BOSTON WATER-SUPPLY SYSTEM.

E. R. B. Allardice—Boston Society of Civil Engineers.

THE marginal lands of the great inland lake known as the Wachusett Reservoir, which was created some years ago for the storage of the water supply of Greater Boston, aggregate 3,380 acres, and in places extend back for half a mile. Early in the development of the water-supply system it was appreciated that if the lands bordering the reservoir were allowed to go to waste, such a condition would be a detriment to the purity of the water supply and a menace to the life of the soil. A small part of the lands were suitable for agricultural purposes, but cultivation and pasturage so close to a source of domestic water supply would create more dangerous conditions than the non-use of the lands. The only course open to the Metropolitan Water Board was to reforest in some way the whole or part of the reservation. The work of reforestation has been in progress for some years, and at the end of 1908 a total area of 1,330 acres had been planted. E. R. B. Allardice has given a comprehensive description of the reforestation in a recent paper before the Boston Society of Civil Engineers, which is printed in the *Journal of the Association of Engineering Societies* for January. We subjoin a few data of the forestry practice and of the cost of the work.

The problem which confronted the Metropolitan Water Board was not one of forestry simply. No precedents existed for the guidance of the Board in making of forestry an important branch of the modern large water supply. While the prospect of financial return was an important consideration, the paramount object in undertaking the reforestation of the reservoir lands was to preserve and increase the purity of the water supply and to protect the margin of the reservoir against damaging floods. The ordinary problems of commercial forestry were complicated by many perplexing conditions arising out of the peculiar relation of the reforestation project to the water supply.

The preliminary investigations showed the reservoir lands to be "made up of small parcels so varied in growth, soil and topography that hardly any two offered the same treatment. The arable lots, pastures and sparsely grown sprout lands offered a splendid opportunity for the practice of modern forestry. The more hardy sprout lands and timber forests could, by the expenditure of comparatively small amounts, be made paying property by cutting out the dead and undesirable trees, thereby giving more light, air and nourishment to the remaining hardy specimens, and assisting nature in the development of a valuable forest. The large areas grown to herbaceous plants, sedges and scrub oaks, of which a large percentage of the reservation was composed, which, therefore, could not be neglected in the solving of the problem, offered an excellent opportunity for experimental features in sylviculture."

The recommendation of the forestry expert employed was "that the entire un-forested portion of the reservation be planted with native white pines, making a self-perpetuating forest, which would ultimately provide a complete ground cover, requiring no artificial fertilizing or disturbing of the soil, and which would protect the waters of the basin from the direct contamination of manurial matters and soil washed from adjacent farms during heavy freshets or spring floods. The white pine was selected because of its almost universal adaptability to the various kinds of land and growth to be treated, its freedom from leaves, its rising value in the lumber market, and the ease, low cost and certainty of raising it to maturity.

"An outline of the general policy adopted in the reforestation of the marginal lands of the Wachusett Reservoir, comprising as they did 1,090 acres of arable, pasture and light sprout land; 280 acres of thick sprouts and young, thin timber land; and 1,475 acres of heavy timber or forest land, was as follows: first, to establish two forest nurseries, one on each side of the reservoir, for the raising from seed of coniferous trees, mostly native white pines, to form the ultimate or final forest, and of deciduous trees to act as fillers and aid in the final development of the conifers; second, to plant all of the first mentioned class of land with a mixture of white pines and hardwoods; third, to underplant the second class with white pines, making improvement thinnings as the growth of the pines demanded; fourth, to make improvement thinnings in original timber stands, as opportunity permitted; fifth, to clear and maintain a fire guard 40 feet wide around the outside limit of the reservation, to serve as a protection against fires having their origin on abutting land; sixth, to maintain some of the present, and build necessary additional, internal forest roads, 15 feet wide, making accessible all areas, and acting as secondary fire lines, dividing the entire reservation into lots containing from 15 to 30 acres; and seventh, to clear and maintain a 50-foot margin along the forested portion of the flow line of the reservoir and to plant the inside half of it with white pine and arbor vitæ closely spaced, forming an effectual screen or hedge to keep the greater part of the foliage from adjoining forests from being blown into the reservoir."

Early in 1898, about eight years before the completion of the reservoir, work was begun on the first nursery, about 4.3 acres in extent. About two years later a second nursery, containing about 3.7 acres, was planted. We do not propose, in this brief review, to attempt to give in detail Mr. Allardice's minute description of the methods followed in raising the trees from seed, transplanting them to their final location on the reservoir reservation, and caring for them during the early years of their growth. Dealing first with the conifers, however, we may say that they were raised from seed in drills, and were transplanted at the end of one year into transplant beds, where they were spaced about 4 inches apart in rows 6 inches apart and left from one to three years. Field planting was done in both spring and fall, with no apparent difference in the results obtained. The maximum cost of this work was $7.87 per thousand trees; this was in heavy grass land. Under average conditions, with a well organized and experienced gang, two men will plant about 2,000 trees per 9-hour day, at a cost, including the nursery work, of about $3.25 per thousand trees. Remarkably successful results have been obtained with the white pine and other conifers, 90 per cent. of the trees placed in the field having lived.

The raising of hardwoods, maple, oak, chestnut and walnut, on the other hand, has largely failed. The first seedlings planted were transferred directly from the nursery to the field at the age of one year. Nearly all these trees died and their failure was attributed to the early age at which they were planted. Subsequently transplanting was practiced, and while the seedlings seemed to improve in the transplant beds, they continued to die rapidly in the field. The conclusion was finally reached that the soil in the nurseries was not suited to growing hardwoods and finally their culture was abandoned.

TABLE OF WORK ACCOMPLISHED TO DECEMBER 31, 1908.

Total area of nurseries	8.0 acres
Total area planted	1,330 acres
Total number of trees planted: coniferous	948,000
deciduous	902,000
Total length of reservoir margin planted	32 miles
Total length of fire guard cleared and maintained	20.8 miles
Total length of forest roads cleared and maintained	30.0 miles
Planted area thinned	488 acres
Original timber stands thinned	209 acres

TABLE OF COSTS. WAGE RATE, $1.75 PER EIGHT-HOUR DAY.

Nurseries:	
Clearing nursery on south shore	$200.00 per acre
Maintenance of nursery, first year seedlings	$1.50 per M.
Maintenance of nursery, second and third year seedlings	$1.75 per M. per year
Plantings:	
Clearing areas preparatory to planting	$4.00 per acre
Transplanting seedlings from nursery to field	$5.25 per M.
Transplanting seedlings from nursery to field, 6 feet by 6 feet planting	$5.50 per acre
Improvement thinnings:	
Among planted trees	$6.00 per acre
In original timber stands	$20.00 per acre
Fire protection:	
Clearing marginal fire guard 40 feet wide	$150 per mile
Maintaining marginal fire guard	$27 per mile per year
Clearing and grading forest roads 15 feet wide	$120 per mile
Maintaining forest roads	$8 per mile per year
Maintaining fire patrol	$100 per year

REFORESTATION. SUMMARY OF COSTS ON PLANTED PINE STANDS.

	Per 1,000 trees planted.	Per acre planted.
Preparing nurseries	$0.40	$0.60
Seedlings (1 year)	1.50	2.25
Transplants (2 years)	3.50	4.50
Preparatory clearing	3.00	4.00
Field planting	5.25	5.50
Clearing 40-foot fire guard	0.75	1.00
Clearing 15-foot forest roads	1.00	1.35
Maintaining fire guard, per year	0.14	0.19
Maintaining forest roads, per year	0.06	0.09
Maintaining fire patrol	0.02	0.03
Improvement clearing	4.25	6.00

"The original condition of the area to be treated being so varied, it was necessary to vary the composition of the artificial stand to meet the requirements of the individual lot. In the main, the plantings comprised white pines planted 10 feet by 10 feet apart, using oaks, chestnuts and maples as fillers, making the final stand with trees 5 feet by 5 feet apart, the theory of this composition being that the hardwoods, growing so much faster than the pines, would thrash their young and tender limbs, thereby forcing them to grow upwards and developing a long, straight, clear log. This type of planting required 435 pines and 1,307 hardwood trees per acre and was used in arable, open pasture and light sprout land. In the thick sprout and young, thinly grown timber land, the pine seedlings were used to underplant the sprouts and interplant the open spaces of the timber land. The first plantings were made during 1902, and from then up to the time that the failure of the hardwoods was discovered (1906), the mixed type of planting was used. Since that time no hardwoods have been planted and the pine seedlings have been spaced 6 feet by 6 feet apart in the field. This spacing required 1,210 trees per acre."

Improvement thinning of the sprout and scrub lands was found necessary to give the young pines light and air. The aim was ultimately to secure a sound, healthy stand of pure white pines, having from 250 to 350 trees per acre. The method of improvement thinning adopted was to cut out all growth that might in any way stunt or kill the trees. Similar thinning was practiced in the existing timber stands. The fire roads require cutting over once every year.

"The tables show that it costs about $15.40 per thousand trees, or $19.20 per acre (1,390 trees per acre), to raise the trees from seed, prepare, plant and protect the lands planted through the time of final planting in the field; that it costs about 22 cents and 31 cents per year respectively to maintain efficient fire protection; that in sprout and scrub land it costs about $4.25 and $6.00 respectively for an improvement thinning, which will probably have to be made twice during the first ten years, after which time the trees should care for themselves."

DRYING BLAST WITH CALCIUM CHLORIDE.

A BRIEF DESCRIPTION OF A NEW PROCESS FOR THE DESSICATION OF BLAST-FURNACE AIR.

F. Daubiné and E. Roy—Bulletin de la Société de l'Industrie minérale.

AFTER a long series of investigations, two French metallurgists, MM. F. Daubiné and E. Roy, have succeeded in developing a cheap and efficient process for drying blast-furnace air by means of calcium chloride, which they describe in full in the *Bulletin de la Société de l'Industrie minérale* for November and December, 1909. They were first attracted to the problem by the success of the Gayley refrigerating process at Cardiff. Taking the case of a blast furnace with an output of 130 tons per day using moist air, located in Lorraine at a considerable distance from a source of coke supply, MM. Daubiné and Roy calculated that by drying the blast the output of the furnace could be increased to 150 tons per day and at the same time the cost of production could be reduced by from 40 to 60 cents per ton. For a plant of this size, however, the Gayley process was much too expensive, both in first cost and in cost of operation. The expense of installing a refrigerating plant would be at least $60,000, and the operation, maintenance and depreciation cost would be very close to 40 cents per ton.

In the hope of discovering a less costly process, MM. Daubiné and Roy took up the systematic study of hygroscopic substances. They found that calcium chloride, the cheapest, most active, and most easily handled of all hygroscopic materials, is capable of retaining at least as much water as is extracted from the air by the Gayley refrigerating process, and, further, that the regeneration of saturated calcium chloride can be effected by very simple means, merely by the application of heat. In designing apparatus for utilizing the hygroscopic properties of calcium chloride for drying air, and for regenerating the spent material, it was found necessary to take into account certain practical considerations. The hygroscopic power of calcium chloride is greater at low temperatures. In the interests of economy, therefore, it is necessary to effect the drying process before the air reaches the blowing engines; otherwise the air, being heated during compression, would have to be re-cooled before entering the drying apparatus. Further, calcium chloride becomes heated in the process of absorbing moisture and in order to keep down the temperature of the mass, the grating on which it is carried must be cooled by the circulation of cold water. The rate of absorption of the chloride falls as drying progresses; hence the speed of the air passing through the mass must gradually decrease, necessitating a gradual increase in the sectional area of the dehydrating mass. The hydrated mass formed on the surface of fragments of calcium chloride is fluid and has a tendency to run; the air must be passed downward through the mass of chloride, so that if the hydrated mass becomes fluid enough to flow, it will be caught and held on the less hydrated fragments below. Finally, to preserve its efficiency, the calcium chloride must be protected against contamination. If furnace gas is to be used to regenerate the spent material, it cannot be allowed to operate directly on the surface of the chloride on account of the danger of dust being deposited in such quantities as to destroy the hygroscopic power of the substance. In addition to this danger, there is a considerable risk of converting a portion of the chloride into carbonate by the action of carbon dioxide.

The process developed by MM. Daubiné and Roy take account of all these considerations. Each apparatus is composed of ten similar and superimposed units, measuring about 10 feet square and 16 inches in height. Each unit has three elements: (1) a grating of water-cooled, externally ribbed tubes, which carries the calcium chloride; (2) a series of tubes, triangular in section, imbedded in the chloride and resting on the grating on one of their edges, through which furnace gases are passed; and (3) two flat sheet-iron chambers, one located at the moist-air intake, the other at the dry-air outlet.

The air to be dried is impelled by a fan into a distributing conduit, whence it is distributed among the intake chambers mentioned above, and from these chambers it passes into the various units of the apparatus. The air then passes downward through the mass of the chloride, which offers to the air a gradually increasing section, as the free air space between the triangular tubes for the heating gases increases progressively downward, from 58 square feet at the top to 97 square feet at the bottom. The dried air passes into another collecting chamber, whence it is led to the intake of the blowing engine. The intake of the moist air and the outlet of the dry air are placed in diametrically opposite positions, to ensure equality of resistance to the passage of the air in all the units, and to prevent any short circuiting, which would cause unequal deposition of moisture.

In the regenerative process the hot gases are led from the flue into a distributing chamber, whence they are distributed among the different sets of triangular tubes. After passing through the tubes they enter another chamber which communicates either with a chimney or with an exhaust fan. During the passage of the heating gases through the triangular tubes a second fan draws through the chloride a regenerating current of air in a direction opposed to that of the air going to the blowing engines. By regulating the speed of this fan, the temperature of the mass of chlorine can be adjusted to effect progressive heating, and it can be prevented from rising above 235 degrees C., the maximum limit permissible.

Each blast furnace is provided with four apparatus of the type described. At any given time, one is in operation for drying the blast, one is being heated to dry the chloride, one is being cooled and the fourth is held in reserve or is being repaired or cleaned. The operation of each set is changed at stated intervals, for example, every hour. The substitution of the regenerative process for the drying process is effected by shutting off communication with the air fan, opening the admission and outlet valves for the heating gases, and opening the valve leading to the small fan which produces the regenerative air current. The heating of the calcium chloride is carefully observed by means of pyrometers inserted in the mass. To start the recooling process, all openings are closed and a very rapid current of air, in volume not more than a few hundred cubic feet per hour, is drawn through the gratings.

The type of apparatus described above is especially suited to works where no surplus motive power is available and where it is necessary to utilize the heat of the furnace gases in the most efficient and economical manner. In plants which have a large surplus of furnace gases, as is the case in many ironworks producing pig iron alone, it may be more economical to waste the furnace gases used in the drying process for the sake of obtaining convenience of construction and facility of operation of the drying apparatus. For such plants MM. Daubiné and Roy propose a second and simpler form of apparatus. The triangular heating tubes within the mass of the chloride are omitted and the units of the drying apparatus consist of only the water-cooled grating and the hygroscopic material. The drying of the air is effected in the manner already described, but the regeneration of the chloride is carried out by a different procedure. The drying air from the secondary fan is passed through an apparatus resembling a Green economizer. The air flows through a series of externally ribbed tubes surrounded by hot furnace gases or by a similar heating medium. Heated thus it is drawn upward through the mass of spent chloride. At the temperature at which the air leaves the economizer (235 degrees C.) it is capable of absorbing very large quantities of water vapor and acts on the chloride both as a heating and as a drying agent. One economizer is provided for the four drying units of each blast furnace and operates continuously, the hot air being drawn into each unit in turn, as occasion requires.

The researches of MM. Daubiné and Roy have been carried out on an experimental apparatus, with an output of 3,500 cubic feet of air per hour. Under average conditions it has been found that the calcium chloride easily dessicates ten times its own weight of air. Allowing a margin of 100 per cent. on the quantity of chloride required, the first purchase will not exceed 25 long tons, at a cost of $500. The total cost of the equipment for each furnace, including the 30 and 20 horse-power fans required, will not exceed $10,000. The material being non-volatile, the waste of calcium chloride must be small, but even if the supply had to be renewed every ten days, the cost would be only $10 per day. The apparatus would require the attention of only one man per shift, and the power and labor costs would be small, not more than $11 per day. Including an allowance of 4 per cent. for depreciation, the total cost, as estimated by MM. Daubiné and Roy for a furnace with a daily output of 150 tons, is $24.40 per day, or 16 cents per ton. The Gayley process, with refrigerating machinery, costs 39 cents per ton, so that the balance in favor of the calcium-chloride process is 23 cents, a saving of over 50 per cent.

MECHANICAL GEARING FOR MARINE TURBINES.

AN APPLICATION OF THE MARINE STEAM TURBINE AND MECHANICAL GEARING IN A MERCHANT SHIP.

Hon. C. A. Parsons—Institution of Naval Architects.

THE use of mechanical gearing as a solution of the problem of adjusting propeller to turbine speed in marine-turbine propulsion has been brought into prominence during the last few months by the reports published in the technical press of the Melville-Macalpine-Westinghouse double-helical spur gear, a description of which has already appeared in these columns.* This system of gearing, however, is not the only one which has been devised for the purpose. In a paper read at the recent meeting of the Institution of Naval Architects, which is reprinted in *Engineering* for March 25, Hon. C. A. Parsons describes the substitution of turbines and mechanical gearing for reciprocating engines in a typical, slow-speed (10 knots) merchant vessel, and gives a summary of the results obtained in trials of the vessel at sea.

The success of the experiment is of very great significance. As remarked by Professor Biles in the discussion on Mr. Parsons' paper, in high-speed ships a satisfactory compromise has been arrived at between the speed of the propeller and the turbine; while in ships of intermediate speed the combined system of reciprocating engines and turbines has proved satisfactory. Mr. Parsons' paper indicates that a new field is about to be invaded by the steam turbine—that of slow-speed vessels. How imminent the invasion is, may be judged from the following discussion of the experiment and of the economy of the gearing system, as disclosed by the results of sea trials.

"In the summer of last year the directors of the Turbinia Works Company decided to test turbines mechanically geared to the screw shaft of an existing typical slow-speed vessel, and a cargo vessel named the *Vespasian* was purchased for this purpose. The *Vespasian* was built in 1887. Her dimensions are:—Length, on load water line, 275 feet; breadth, moulded, 38 feet 9 inches; depth, moulded, 21 feet 2 inches; mean loaded draught, 19 feet 8 inches; and displacement, 4,350 tons.

The vessel had originally an ordinary triple-expansion, surface-condensing engine, with cylinders 22¾ inches, 35 inches, and 59 inches in diameter, by a 42-inch stroke. The air, circulating, feed and bilge pumps were driven from the intermediate-pressure cross head, with the usual arrangement of levers and links. The condenser was cast with the back columns of the main engine, and had a cooling surface of 1,770 square feet. The boilers—two in number—are 13 feet in diameter by 10 feet 6 inches long, with a total heating surface of

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*The Engineering Magazine, November, 1909.

3,430 square feet, and grate area of 98 square feet, working under a pressure of 150 pounds with natural draught. The propeller is of cast iron, and has four blades, having a diameter of 14 feet, a pitch of 16.35, and an expanded area of 70 square feet.

"With a view to obtaining comparative data between the turbine installation and the reciprocating engine, it was decided to run trials with the vessel with her reciprocating engine previous to its removal, and the installing of the turbines and gearing. Before proceeding on the voyage upon which data regarding the performance of the reciprocating engine were taken, the propelling machinery was completely dismantled and overhauled. The high-pressure piston valve-chamber was re-bored and new valve-rings fitted; slide-valves were replaced and faced up; bearings were renewed, and other repairs carried out wherever necessary to bring the machinery into an efficient condition and first-class working order. To obtain reliable measurements of water consumption, two tanks were fitted, each of 400 gallons capacity, with suitable change-cocks and connections for the air-pump to discharge through these measuring tanks.

"It was necessary, for the purpose of obtaining data under service conditions, that the vessel should be run at her loaded condition. Arrangements were consequently made with a firm of ship-brokers to take a cargo of coal from the Tyne to Malta, and on June 26, last year, the *Vespasian* left the Tyne, in a loaded condition, with a special recording staff on board, and on this voyage careful measurements of coal and water consumption were made.

"On the completion of the voyage, the vessel returned to the Turbinia Works, where her reciprocating engine was taken out, engine-seats remodeled, and preparation made for the reception of the turbines and gearing. The only alteration made to the vessel was in the type of propelling engines; the boilers, propeller, shafting, and thrust-blocks remained the same as for the reciprocating engine. The propelling machinery consists of two turbines in 'series'—viz., one high-pressure and one low-pressure, the high-pressure turbine being placed on the starboard side of the vessel and the low-pressure on the port side. At the after end of each of the turbines a driving pinion is connected with a flexible coupling between the pinion shaft and the turbine, the pinion on each side of the vessel being geared into a wheel, which is coupled to the propeller shaft.

"A reversing turbine is incorporated in the exhaust casing of the low-pressure turbine. The air, circulating, feed, and bilge pumps are of the usual design for tramp steamers, and are driven by means of a crank and connecting rod coupled to the forward end of the gear-wheel shaft. The turbine and pinion-shaft bearings are under forced lubrication, as in ordinary turbine practice. The teeth of the pinions and of the gear wheel are lubricated by means of a 'spray' pipe extending the full width of the face of the wheel. Independent oil pumps are fitted for supplying oil to the bearings and gear wheel. With a view to the possibility of experimenting with different lubricants for the gear wheel, the oiling system for the bearings is separate from that of the gear wheel.

"The high-pressure turbine is 3 feet maximum diameter by 13 feet over-all length, and the low-pressure 3 feet 10 inches in diameter by 12 feet 6 inches length. The turbines are similar in design to a land turbine, being balanced for steam thrust only, the propeller thrust being taken up by the ordinary thrust block of the horse-shoe type, which is fitted aft of the gear wheel. A new condenser, together with a vacuum augmentor, is fitted with the turbine installation. The cooling surface of the condenser is 1,165 square feet.

"The gear wheel is of cast iron, with two forged steel rims shrunk on. The diameter of the wheel is 8 feet 3½ inches pitch circle, having 398 teeth—double helical—with a circular pitch of 0.7854 inch. The total width of the face of the wheel is 24 inches; the inclination of teeth 20 degrees to the axis. The pinion shafts are of chrome nickel steel, 5 inches in diameter pitch circle, with twenty teeth 0.7854 circular pitch. The ratio of gear is 19.9 to 1."

After the reciprocating engine of the *Vespasian* had been overhauled, and before she was sent on her voyage to Malta, a series of trials was made on the Whitley Bay mile. On the completion of the turbine-gearing equipment another series of trials was run with the vessel loaded to the same draught and displacement as in the Whitley Bay trials. Mr. Parsons gives in tabular form the results of the two series of trials, and also a graphical comparison of the results in a series of charts plotted from the tabular data. Without reproducing the results in detail, we may summarize their more significant features. The speed was increased by one knot per hour, owing to the higher efficiency of the turbines, while at the same time the water consumption, and consequently the coal consumption, was reduced nearly 20 per cent. The weight of the reciprocating machinery was 100 tons, as compared with 75 tons for the new installation, a saving of 25 per cent. The results show, therefore, that the installation of mechanically geared steam turbines in slow-speed merchant vessels gives them, in comparison with vessels with reciprocating engines, the advantage of additional capacity, and a saving in coal and oil, in engine-room staff, and in upkeep, the latter following the lower working steam pressure.

The turbines and gearing have given little or no trouble, and have worked satisfactorily, with very little noise or vibration, throughout the trials. Further, there is no appreciable wear on the teeth or bearings. It is proposed to put the vessel into commercial service and run extended trials, the results of which will be watched with very considerable interest.

BRITTLENESS IN MILD STEEL.

THE RESPONSIBILITY OF COMBINED NITROGEN FOR FAILURES OF MILD-STEEL PLATES.

C. E. Stromeyer—Institution of Naval Architects.

THE investigation of the causes of failure of mild-steel plates is a field which Mr. C. E. Stromeyer has made peculiarly his own. His work as chief engineer of the Manchester Steam Users' Association has given him unusual opportunities for collecting data at first hand, and even before the modern theory that brittleness is attributable to the influence of combined nitrogen was propounded about four years ago by M. Hjalmar Braune, Mr. Stromeyer's annual reports rarely failed to summarize the best available information on the subject. One of these reports was abstracted in the columns of THE ENGINEERING MAGAZINE for December, 1906. This report contained no mention of Braune's results, but all of Mr. Stromeyer's subsequent work has taken account of the nitrogen theory, and it is not too much to say that its confirmation has been largely due to his investigations. A summary of present knowledge is given in a paper read by Mr. Stromeyer at the recent meeting of the Institution of Naval Architects, from which we quote at length.

"During the last few years I have been engaged on rather exhaustive experiments with mild steel plates, some of which had come out of exploded boilers, while others had failed in the workshop and yet others were of good quality. These experiments were undertaken to ascertain, if possible, whether any mechanical tests could be relied upon to discriminate between such plates as behave well both when tested and subsequently and such as behave well when tested but fail either in the workshop or when put to use in a boiler. The mere statement of this aim implies a suspicion that a structural or molecular change may take place in mild steel while at rest, and my attention was naturally at first directed toward discovering whether any steels possessed ageing qualities. A test was devised which consisted in planing the edges of the test pieces, nicking them with a chisel, and then bending them, either at once or after waiting days, weeks or months, or after boiling the samples for a few minutes at a temperature of 212 degrees F., which boiling, so it was found, has the same effect as prolonged waiting. The change of ductility at the nick, where the material has been as much injured as when plates are calked, could easily be detected by measuring the curvatures near the nicks, the edges having been filed flat before bending.

"Marked ageing effects were noticed in 24 out of 26 steels dealt with. One of the two exceptions (but this is a doubtful case) was a chrome vanadium steel, and the other sample was exceptionally rich in sulphur. Samples containing much phosphorus did not seem to be as much affected by ageing and boiling as the other samples, and no marked difference could be detected between steels which had failed in practice and others of presumably good quality. Temper and cold bending tests, percussion tests, alternate bending tests and fatigue tests did not help to detect those steels which had failed in practice, nor did the ordinary chemical analysis help to elucidate matters; and it was only when, after having heard of M. Braune's investigations into the effect of nitrogen on steel, this element was also determined in analysis of the steels, that light was thrown on the cause of most of the failures of plates which I had collected."

TABLE OF DEFECTIVE STEELS.

Steel qualities.	Plate marks.	Carbon, per cent.	Nitrogen, per cent.	Phosphorus, per cent.	5 nitrogen + phosphorus.
Bad qualities of steel	Q	0.127	0.0200	0.052	0.152
	L	0.090	0.0153	0.060	0.136
	H	0.210	0.0145	0.079	0.151
	C C	0.130	0.0123	0.047	0.108
	M	0.090	0.0090	0.052	0.097
	U	0.110	0.0066	0.052	0.085
	F	0.097	0.0043	0.210	0.231
	R	0.165	0.0030	0.177	0.192
	K	0.205	0.0041	0.095	0.115
	E	0.165	0.0029	0.076	0.090
	S	0.135	0.0038	0.065	0.084
Uncertain	T	0.200	0.0023	0.038	0.049
Basic O. H. steels.	G	0.215	0.0050	0.051	0.076
	Z	0.195	0.0033	0.039	0.055
Acid O. H. steels.	B	0.200	0.0040	0.032	0.052
	B B	0.200	0.0032	0.029	0.045

Data are given of the process of manufacture and nature of the failure of the plates tested. "The list given above contains those of the steels which actually failed or which were so bad as not to be sent to the boiler works and also a few good steels for comparison. Samples G and Z are basic open-hearth steels, respectively of German and British make, and B and B B are acid open-hearth steels, also of German and British makes respectively. The table contains the leading chemical impurities, and in the last column will be found the sums of the percentages of phosphorus added to five times the percentages of nitrogen. This ratio in the relative brittleness influences has been adopted, partly because it is the inverse ratio of the squares of the respective atomic weights of the two elements and partly because nitrogen has a ten-fold greater effect than phosphorus in raising the tenacity of steel, an addition of 0.01 per cent. increasing the tenacity by about 3 tons. It has been assumed that the relative brittleness effects of the two elements may be even greater than 10 to 1, but are at least as great as 5 to 1, which is the adopted ratio.

"Until quite recently nothing was known about the brittleness effect of nitrogen on steel; as regards phosphorus, 0.060 per cent. was looked upon as a reasonable upper limit, and steel plates containing more than this percentage were expected to give trouble in the works due to cold shortness. This view has now to be modified; at any rate, sample C C, which was undoubtedly a very bad quality, possibly produced by the same process as the notorious boiler plates of the Imperial Russian yacht *Livadia*, contains only 0.047 per cent. phosphorus, but it also contains 0.0123 per cent. nitrogen, which is more than twice as much as that contained in any of the good steels. Then again Q, which was cut from a boiler plate which also burst under the hydraulic test, contained only 0.052 per cent. of phosphorus but 0.0200 per cent. of nitrogen, which is four times as much as that contained in any good steels. A safer rule to go by than the above is based on the values contained in the last column of the table and may at present be expressed as follows: The sum of the percentage of phosphorus plus five times the percentage of nitrogen should not exceed 0.080 per cent.

"A further conclusion to be drawn from this investigation is that: No investigation into the cause of the failure of a mild steel plate can be considered complete unless both the phosphorus and nitrogen percentages have been determined. The nitrogen determination is extremely simple and rapid, but every possible precaution has to be adopted to guard against contamination by ammonia either in the reagents or in the atmosphere. . . . . .

"A very natural question to ask is, When does the nitrogen get into steel, and how can it be removed when it has got there? The most natural explanation would be that nitrogen is introduced by the contact of molten steel with the nitrogen of the air blasts in the blast furnaces and in the Bessemer converters. This is partly confirmed by the following comparison of Bessemer steels of the above lists with other steels and wrought irons:

"Percentages of nitrogen in Bessemer steels: (L) 0.0153, (H) 0.0145, (60) 0.0108, (20) 0.0160, (40) 0.0150. Percentages of nitrogen in open hearth acid and basic steels of previously mentioned samples, 0.0024 to 0.0050 per cent. Other mild steels: (25) 0.0042; steel forging, 0.0022; bad wrought iron with 0.219 per cent. phosphorus, 0.0084 per cent. nitrogen; charcoal iron, 0.0035.

"In spite of this confirmation of a very natural view on the subject, it has to be borne in mind that as yet it has not been possible to combine nitrogen with steel by merely heating the two together, and that the only means of effecting the combination is to heat steel in an atmosphere of ammonia. Now ammonia is not introduced into Bessemer converters, but it may be present in blast furnaces if the coking of the fuel has not entirely removed the nitrogen which was in the coal. Then, also, it seems as if nitrogen, when once it has entered the pig iron in the blast furnace, cannot be removed by subsequent heating. The suitable chemical for effecting the removal is believed to be titanium, but the addition of ferro-titanium alloy to steel has not demonstrated that this beneficial action takes place. This is probably due to the necessary temperature conditions being as yet unknown, but nevertheless a strong argument in favor of the belief that titanium can remove or keep down the percentage of nitrogen was recently brought to my notice by the discovery inside the now dismantled blast furnaces of the Farnley Iron Company of some crystals of titanium nitride. To my mind, unsuspected traces of titanium in the Farnley iron ores may have been the reason why the product always enjoyed a high reputation for reliability.

"Under these circumstances it seemed desirable to ascertain more definitely how titanium acts in practice, but it was only with great difficulty that the necessary samples could be obtained. It appears that attempts to introduce titanium by adding its ores in the blast furnace have not been a success, nor have additions of titanium ores or titanium iron alloys to molten steel or cast iron resulted in marked improvements, and in none of these cases has the nitrogen percentage been determined. Of late, however, since the production of practically pure titanium has been effected, its addition to steel and cast iron has been attended with varying degrees of success, more particularly in removing blow holes, and I have been able to analyze one pair of cast steel samples and a pair of cast iron samples. Unfortunately, the original charge of cast iron contained very little nitrogen, viz., 0.0014 per cent., but even in this case the addition of 0.2 per cent. of titanium reduced the nitrogen to 0.0013 per cent., but the slight difference is smaller than the possible errors of analysis. Of the two cast steels the untreated one contained 0.0063 per cent., which was reduced in the other sample to which titanium had been added to only 0.0045 per cent. Further attempts in this direction may perhaps lead to the removal of nitrogen from Bessemer steel and thus make it available for plates.

"It may be thought that the brittlenesses, which have here been attributed to nitrogen, are due to hydrogen, for it is known that this gas imparts extraordinary hardness to otherwise pure iron, but it is also known that hydrogen is easily driven out by heating the steel, and it is, therefore, improbable that appreciable quantities of hydrogen should remain after melting and reheating for rolling."

THE ENGINEERING INDEX

"THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

Note—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

Divisions of The Engineering Index.

Civil Engineering..............Page 277
Electrical Engineering.......... " 287
Industrial Economy............. " 292
Marine and Naval Engineering. " 293
Mechanical Engineering........Page 295
Mining and Metallurgy......... " 306
Railway Engineering........... " 312
Street and Electric Railways... " 316

CIVIL ENGINEERING.

BRIDGES.

Abutments.

See Piers, under Bridges.

Arches.

Tests of Model Concrete Arches by the New York State Engineer's Office. Description, with illustrations, forming a portion of a report in the *Barge Canal Bul.* for Feb. 3500 w. Eng News—March 10, 1910. No. 12215.

See also Aqueducts, under Water Supply.

Concrete.

Comments on Contracting for Concrete Bridges with Description of a Form of Cost Recording. Extract from a paper by Daniel B. Luten, read before the Am. Soc. of Engng. Con. 1600 w. Engng-Con—March 2, 1910. No. 12100.

Short-Span Single-Track Concrete Arch Bridges. Bridges on the Lake Champlain & Moriah Ry. are illustrated and described, giving costs. 1200 w. Eng Rec—March 19, 1910. No. 12369.

Deflection Tests.

Deflection Tests of Railway Bridges. Conrad Gribble. An illustrated study of tests and loadings. 4000 w. Cassier's Mag—March, 1910. Special No. No. 12514 D.

Failures.

A Reinforced-Concrete Arch Highway Bridge in Indiana Wrecked by Erosion of Foundations. Illustrates and describes the structural design and failure of the Pugh's Fork bridge, over the Flat Rock river, near Edinburg, Ind. 1600 w. Eng News—March 17, 1910. No. 12311.

Piers.

The Substructure of the P. & L. E. R. R. Bridge Over the Ohio River at Beaver, Pa. A. R. Raymer. Explains reasons for building this new bridge, and gives illustrated description of the substructure, consisting of two abutments and three piers of concrete, faced in part with sandstone. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1910. No. 12547 D.

Reconstruction.

Strengthening of Railway Bridges in America. George Sherwood Hodgins. Illustrates and describes methods of reconstruction to meet the demands of greater traffic and heavier rolling stock. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12520 D.

Reconstruction of Boylston Street Bridge at Boston. Illustrated detailed description of the conditions which led to the deterioration and the means adopted for the restoration under difficult conditions and for its future protection. Also editorial. 5500 w. Eng Rec—March 5, 1910. No. 12143.

The Atbara Bridge. An account of the proposed method of strengthening this bridge to meet the present requirements. by renewing the main girders. 1200 w. Engr, Lond—March 11, 1910. No. 12501 A.

Reinforced Concrete.

A Reinforced Concrete Sewer Bridge. Henry Ryon. Illustration with brief description of a construction at Morristown, N. J. 1000 w. Eng Rec—March 26, 1910. No. 12662.

Reinforcement of Fulmer Creek Bridge with Steel and Concrete. Illustrates and describes methods of reinforcement of the bridge on the Utica & Mohawk Valley R. R., made necessary by the use of heavier equipment. 1200 w. Elec Ry Jour—March 26, 1910. No. 12652.

Three-Hinge Reinforced Concrete Arch Over Schöneberger Street, Gaarden (Dreigelenkbogenbrücke in Eisenbeton über die Schöneberger Strasse in Gaarden). J. Gaugusch. Mathematical discussion of the design of a unique foot bridge. Ills. 3000 w. Beton u Eisen—Feb. 20, 1910. No. 12404 F.

See also Failures, under BRIDGES.

Steel.

Two Bridges in Berlin. Montgomery Schuyler. Discusses bridge design and illustrates the "Borsigsteg" and the Swinemuende bridge. 2500 w. Archt Rec—March, 1910. No. 12022 C.

Railway Bridge Over the Nami-Ti Gorge. Brief illustrated description of a peculiar and ingenious bridge on the Yun Nan Railway, China. 700 w. Engr, Lond—March 18, 1910. No. 12742 A.

Steel Bridges on the Yun-Nan Railway, China (Les Ponts Métalliques au Yun-Nan, Chine). Georges Bodin. Illustrated description of the Nam-Ti bridge, of a curious type. 3500 w. Génie Civil—Feb. 12, 1910. No. 12438 D.

See also Reconstruction, under BRIDGES.

Trestles.

Albemarle Sound Bridge, Norfolk & Southern Ry. Explains conditions and gives an illustrated detailed description of a pile trestle with two large movable spans and five fixed spans. 2500 w. Ry & Engng Rev—Feb. 26, 1910. No. 12023.

Viaducts.

The Shepherdstown Viaduct, Norfolk & Western Railway. Illustrated description of single-track steel structure across the Potomac River, 1438 ft. long. 1200 w. Eng Rec—March 19, 1910. No. 12368.

CONSTRUCTION.

Arches.

See Roofs, under CONSTRUCTION.

Beams.

The Influence of Holes or Slits in the Neutral Axis on the Strength of Beams (Der Einfluss von Löchern oder Schlitzen in der Neutralschicht gebogener Balken auf ihre Tragfähigkeit). C. Pfleiderer. Mathematical discussion with results of tests. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12616 D.

See also Columns, under CONSTRUCTION.

Coal Pockets.

Coal Pockets at the Lausanne Gas Works (Les Silos de l'Usine à Gaz de la Ville de Lausanne). S. de Mollins. Describes interesting reinforced-concrete construction. Ills. 1000 w. Bul Tech d l Suisse Rom—Feb. 10, 1910. No. 12425 D.

Columns.

A Study of Base and Bearing Plates for Columns and Beams. N. Clifford Ricker. Aims to produce a series of accurate formulae and tables for the different forms and materials of base and bearing plates; and to devise a similar series of formulae based on the common theory of fracture of such plates, testing the accuracy. Ills. 3500 w. Univ of Ill—Bul. 35. July 28, 1909. No. 12318 N.

See also Reinforced Concrete, under CONSTRUCTION.

Concrete.

A Method of Depositing Concrete by Chutes in Building Construction with

Costs of Actual Work. Illustrated description. 1500 w. Engng-Con—March 30, 1910. No. 12704.

Method of Laying Concrete Under Water Using a Tremic; Detroit River Tunnel. Olaf Hoff. Read before the Nat. Assn. of Cement Users. Considers briefly the laying concrete under water by means of bags and by drop-bottom buckets, and the difficulties in depositing by means of tremics, and how they were overcome. 2200 w. Engng-Con—March 2, 1910. No. 12101.

See also Roofs, under CONSTRUCTION.

Concrete Blocks.

See Roads, under MUNICIPAL ENGINEERING.

Demolition.

Demolition of the Old Union Station at Worcester. C. H. Gilman. Brief illustrated description of methods used. 600 w. Eng Rec—Feb. 26, 1910. No. 12027.

Excavation.

Some Records of Work With a Scraper Bucket Excavator on the New York Barge Canal. A record of work accomplished by a Class C, Lidgerwood-Crawford scraper bucket excavator. 1000 w. Engng-Con—March 23, 1910. No. 12575.

See also Rock Removal, under WATERWAYS AND HARBORS.

Failures.

See same title, under BRIDGES; Dams, under WATER SUPPLY; and Canal Regulators, under WATERWAYS AND HARBORS.

Floors.

A Method of Long Span, Light Floor, Reinforced Concrete Construction, with Comparative Costs. Emile G. Perrot. Read at convention of Nat. Assn. of Cement Users. Describes a method of interest because of the unusual length of the span. 900 w. Engng-Con—March 2, 1910. No. 12098.

Grain Elevators.

An Investigation of Grain Pressures at Buenos Aires (Druckversuche in Buenos Aires). E. Lufft. Describes methods and results of investigations to determine the pressure of grain in cylindrical bins. Ills. 2800 w. Beton u Eisen—Feb. 20, 1910. No. 12496 F.

Greenhouses.

Inside-Glazed Greenhouses in the Berlin Botanical Gardens. Illustrations and brief description of greenhouses in which the trusses and all other framing is outside the glass roof, to remove them from the action of the most interior atmosphere. 800 w. Eng News—March 17, 1910. No. 12306.

Indeterminate Stresses.

Stress-Lines and Stream-Lines. Examines the assumed analogy between stress-lines and stream-lines, pointing out the deficiencies. 2500 w. Engng—March 11, 1910. No. 12393 A.

Pile Driving.

The Bucyrus Locomotive Pile Driver. Discussion of Walter Ferris' paper describing a new railway pile driver. 1000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12357 F.

Piling.

Cement and Concrete for Protecting Piles in Sea Water. Ralph Barker. Read before the Nat. Assn. of Cement Users. Reviews methods of pile protection, describing especially the use of cement and concrete as applied at San Francisco. 2500 w. Eng Rec—March 26, 1910. No. 12665.

Regulations.

Standard Building Regulations for the Use of Reinforced Concrete. Gives the code voted on in 1909, and amended last week at the Chicago convention of the Nat. Assn. of Cement Users. 4000 w. Eng Rec—March 5, 1910. No. 12141.

Reinforced Concrete.

The Problems of Reinforced Concrete (Problemi attuali sul Cemento armato). Giulio Revere. A brief outline of salient points in reinforced-concrete theory, including methods of testing, structural regulations, etc. 3000 w. Monit Tech—Jan. 30, 1910. No. 12446 D.

Some Mooted Questions in Reinforced Concrete Design. Edward Godfrey. Criticism of present practice in the use of reinforcing rods, stirrups in beams, and other points. 7000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12654 E.

Methods of Calculation of Reinforced-Concrete Structures (Rechenverfahren bei Eisenbetonkonstruktionen). Herm. Hartmann. Mathematical discussion of the design of floor beams. Ills. 4500 w. Beton u Eisen—Feb. 20, 1910. No. 12495 F.

A Simple Method of Computing the Strength of Flat Reinforced Concrete Plates. Angus B. McMillan. Read before the Nat. Assn. of Cement Users. Gives a description of the different methods used to compute the stresses in the "mushroom floor" designed by C. A. P. Turner. 5500 w. Engng-Con—March 23, 1910. No. 12573.

Dimension Formulae for Concrete Mushroom Beams with Single and Double Reinforcement (Dimensionierungsformeln für einfach und doppelt bewehrte Betonplattenbalken). Leopold Herzka. Mathematical discussion with tabular data. Ills. Serial. 1st part. 8000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 26, 1910. No. 12491 D.

The Calculation of Reinforced Concrete Beams (Sul Calcolo corrente delle Travi a Traliccio con Maglie rettangolari). A. Danusso. Mathematical discussion of a special case. Ills. Serial. 1st part. 2800 w. Il Cemento—Feb. 15, 1910. No. 12448 D.

Longitudinal Reinforcement in Concrete Columns. Sanford E. Thompson. Read before the Nat. Assn. of Cement Users. Shows that tests prove that vertical steel bars embedded in the concrete increase the strength of the column. 2000 w. Cement—March, 1910. No. 12670 C.

Industrial Uses of Reinforced Concrete. M. M. Sloan. This fourth article of a series considers its adaptations to stacks, tunnels, and mechanical equipment. Ills. 2000 w. Engineering Magazine—April, 1910. No. 12686 B.

The Use of Reinforced Concrete in Ice Storage Houses. W. F. Lee. Reviews briefly the history of the use of concrete and reinforced concrete. Discusses its fireproof qualities, its proper construction and cost. 4000 w. Ice & Refrig—March, 1910. No. 12164 C.

Representative Concrete Structures on the New York Barge Canal and Methods of Inspecting, Mixing and Handling Concrete. Russell S. Greenman. Condensed from paper read at convention of Nat. Assn. of Cement Users. Illustrates and describes unusual and difficult work. 3000 w. Engng-Con—March 30, 1910. No. 12767.

Cost of Constructing a Reinforced Concrete Fence Around a Shaft Top. F. Lavis. Illustrated description of the design and construction of a concrete wall around the top of the shaft of the Penn. R. R.'s tunnels at Weehawken, N. J. 1400 w. Engng-Con—March 30, 1910. No. 12762.

A Reinforced-Concrete Machinery Warehouse. H. Milton Boyajohn. Illustrated description of the construction of a warehouse in Chicago. 1200 w. Eng Rec March 12, 1910. No. 12243.

The New Plant of the Carter's Ink Company. Illustrated description of a reinforced concrete factory building in Cambridge, Mass. 2000 w. Eng Rec—March 19, 1910. No. 12370.

A Twelve-Story Concrete Building Without Interior Columns. W. P. Anderson. Illustrated description of a building recently completed in Kansas City, Mo. 1200 w. Eng Rec—March 5, 1910. No. 12144.

The Bismarck Tower in Glauchau (Bismarkturm in Glauchau). M. Bazali. Illustrated description of floor and wall construction. 2300 w. Beton u Eisen—Feb 20, 1910. No. 12493 F.

See also Coal Pockets, Floors, and Regulations, under CONSTRUCTION; Tanks, and Water Towers, under WATER SUPPLY; and Shafts, and Shaft Sinking, under MINING AND METALLURGY, MINING.

Retaining Walls.

A Combined Concrete Fence and Retaining Wall. Illustrated description of work in Detroit, Mich., built by the Michigan Central Railroad Co. 900 w. Eng Rec—Feb. 26, 1910. No. 12026.

Roofs.

The Groined Arch in Filter and Reservoir Construction. Thomas H. Wiggin. Read before the Chicago convention of the Nat. Assn. of Cement Users. Discusses methods of considering the groined arch as a support for vertical loads, and matters related. Ills. 3000 w. Eng Rec—March 12, 1910. Serial. 1st part. No. 12241.

Specifications.

Precarious Expedients in Engineering Practice. Discussion of John Hawkesworth's paper. 4500 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12708 E.

Stacks.

Unusual Method of Erecting 90-Foot Stack. Warren O. Rogers. Illustrates and describes the work. 1500 w. Power—March 8, 1910. No. 12169.

Steel.

Cantilever Construction and Wind-Bracing Details in the People's Gas Light & Coke Co. Building, Chicago. A 21-story building having 18 stories carried on cantilevers is illustrated and described Also the wind-bracing system. 800 w. Eng News—March 10, 1910. No. 12220.

Constructing a Building Above an Underground Station. Cross sections and description of a terminal building in Hoboken, N. J., built above a terminal station, where a proper distribution of loads and a limit of bearing value presented difficulties. 1400 w. Eng Rec—March 5, 1910. No. 12146.

The "New York Times" Building. Corydon Tyler Purdy, with abstract of discussion. Illustrated description of the building, discussing special features of its steel construction due to the existence and operation of the Subway. 13000 w. Inst of Civ Engrs, No. 3800—April 20, 1909. No. 12592 N.

Steelwork in the New York Municipal Building. Illustrated detailed description of a building containing about 25400 tons of structural steel. 4000 w. Eng Rec—March 19, 1910. No. 12364.

Steelwork of the Bryant Building, New York. Illustrates and describes the framework of a 30-story building, containing about 3000 tons of structural steel, 2500 w. Eng Rec—March 26, 1910. No. 12663.

Replacement of the Tower of St. Michael's Church in Hamburg (Wiederaufbau des Turmes der St. Michaeliskirche in Hamburg). B. Hennicke. Illustrated description of the design and erection of a new steel tower on the old foundations. Serial. 1st part. 1800 w. Deutsche Bau—Feb. 26, 1910. No. 12474 B.

See also Greenhouses, under CONSTRUCTION.

Tunnels.

The River Tunnels at New York. J. F. Springer. Illustrated description of the submarine railway tubes for main line service, and their construction. 6000 w. Cassier's Mag—March, 1910. Special No. No. 12523 D.

The New York Tunnel Extension of the Pennsylvania Railroad: The Site of the Terminal Station. George C. Clarke. Describes the preliminary work for, and the preparation of, the site, including the disposal of material excavated. Ills. 14000 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12706 E.

The New York Tunnel Extension of the Pennsylvania Railroad: The Bergen Hill Tunnels. F. Lavis. Illustrated detailed description of the construction, and information relating to the work. 19000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12657 E.

Terryville Tunnel, New York, New Haven & Hartford Railroad. Diagrams and description of the construction of this tunnel near Waterbury, Conn., in connection with improvement of the line. 3000 w. Eng Rec—Feb. 26, 1910. No. 12030.

Constructing the Paris Subway. Lucien Fournier. Illustrated description of the freezing process employed. 1500 w. Sci Am Sup—March 26, 1910. No. 12645.

An Instrument for Measuring and Recording Tunnel Sections. Illustrated description of a tunnel cross-section instrument which automatically plots the cross-section on a reduced scale. 700 w. Eng News—March 3, 1910. No. 12110.

Wage Systems.

See same title, under INDUSTRIAL ECONOMY.

Waterproofing.

Waterproofing Masonry and Bridge Floors. Gives data from an appendix to the report of the Committee on Masonry of the Am. Main. of Way Assn. Ills. 4500 w. Eng Rec—March 26, 1910. No. 12664.

MATERIALS OF CONSTRUCTION.

Cement.

The Portland and Hydraulic Cement Industry (L'Industrie des Cimento Portland de Grappiers et Chaux Hydrauliques). H. Laborbe. A review of the industry and methods of manufacture in France. Ills. 15200 w. Mem Soc Ing Civ de France—Dec., 1909. No. 12406 G.

See also Sewer Pipe, under MUNICIPAL.

Concrete.

A Discussion of the Merits of Concrete for Shop Floors. Leonard C. Wason Examines some of the claims and objections. 3500 w. Am Mach—Vol. 33. No. 13. No. 12773.

The Effect of Alkali on Concrete. Discussion of the paper by George Gray Anderson. 7500 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12709 E.

Tests Upon the Effect of Sea Water on Cement-Sand Mortar Briquettes. Cloyd M. Chapman. Read before the Nat. Assn. of Cement Users. Reports a series of experiments on the tensile strength of cement mortar immersed for various periods in sea water. 500 w. Eng News—March 10, 1910. No. 12219.

Further Tests on the Effect of Electrolysis on Concrete. O. L. Eltinge. An account of experiments in the electrical and testing laboratories of the Rensselaer Polytechnic Inst. Also editorial. Ills. 4200 w. Eng News—March 31, 1910. No. 12778.

Se also Aqueducts, under WATER SUPPLY.

Reinforced Concrete.

Tests of Reinforced Concrete Columns. Peter Gillespie. Read before the Nat. Assn. of Cement Users. Report of tests and statement of conclusions. 3000 w. Eng Rec—March 5, 1910. No. 12142.

Timber Preservation.

The Seasoning and Preservative Treatment of Wooden Cross-Ties. F. J. Angier. A discussion of methods and results, and of problems related. Also general discussion. 20000 w. Pro N Y R R Club—Feb. 18, 1910. No. 12316.

The Strength of Treated Timber. From the report of the Committee on Wood Preservation, at the annual meeting of the Am. Ry. Engng. & Main. of Way Assn. 1200 w. Eng News—March 24, 1910. No. 12584.

Tests of Creosoted Timber. W. B. Gregory. Gives report of tests, and comparison with untreated timber. Ills. 2500 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12656 E.

Preservative Treatment of Poles (Die Verfahren zu Konservierung hölzerner Leitungsmaste). E. F. Petritsch. Outlines preservatives, methods of treatment, and results. 7500 w. Elektrotech u Maschinenbau—Feb. 27, 1910. No. 12606 D.

MEASUREMENT.

Cement Testing.

Testing Cement by the Brinell Ball Method. A summary of facts from recent articles published in French technical papers. 1000 w. Engr, Lond—March 4, 1910. No. 12293 A.

Concrete Testing.

The Use of Beams on a Reduced Scale for Static Tests of Reinforced-Concrete Construction (Impiego delle Travi sperimentali in Scala ridotta per le Prove statiche delle Costruzioni in Cemento armato). Italo Vandone. A discussion of the utility of static tests on small concrete beams. Ills. Serial. 1st part. 3000 w. Monit Tech—Feb. 10, 1910. No. 12447 D.

Surveying.

The Organization of the Bureau of Surveys. E. J. Dauner. Describes the organization of the Bureau of Surveys for the city of Philadelphia. 3500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12567 D.

Marking the Alaskan Boundary. R. E. Robson. Describes methods and work of expeditions in 1908 on the Alsek River, and in 1909 on the 141st meridian in the White River region. Ills. 4000 w. Cal Jour of Tech—Feb., 1910. No. 12320.

Determination of the Meridian. C. E. Rowe. Describes the method of direct solar observation, the instruments, attachments and calculations. Ills. 3000 w. Mines & Min—March, 1910. No. 12085 C.

Air-Bubble Levels (Sur le Niveau à Bulle d'Air). Jules César. Outlines the sources of error and methods of evaluating errors. 1800 w. Bul Sci d l'Assn des Elèves—Jan., 1910. No. 12404 D.

Testing Methods.

See Fuel Testing, under MECHANICAL ENGINEERING, Steam Engineering.

MUNICIPAL.

Asphalt Plants.

Municipal Asphalt Plant, Kansas City, Mo. Plan and illustrated description. 1500 w. Eng Rec—March 5, 1910. No. 12145.

Pavements.

Economics of Street Pavements. From report of Boston Finance Com. by Samuel Whinery. Compares different pavements on basis of cost. Considers factors of durability, and adapting pavement to traffic. 2200 w. Munic Jour & Engr—March 2, 1910. No. 12096.

Suggested Standard Specifications for Macadam, Brick, and Granite Block Pavement, and Concrete Pavement. Suggestions presented by committees appointed by a convention of city officials held at Chicago. 2500 w. Engng-Con—March 9 1910. Serial. 1st part. No. 12198.

Paving Block Inspection at the Manufacturing Plant. W. A. Aiken. Describes methods of inspection with the object of supplying good materials. 1500 w. Munic Engng—March, 1910. No. 12324 C.

Asphalt Block Paving in Toledo. F. I. Consaul. Gives the specifications for blocks and for laying and the improved methods. Ills. 2500 w. Munic Jour & Engr—March 2, 1910. No. 12097.

Brick Pavements in Ohio. Illustrates and describes work in various places. 8000 w. Munic Jour & Engr—March 2, 1910. No. 12095.

Roads.

State Road Work in New York in 1909. Reviews the report of the State Commission of Highways on the first year's operation of the new highway law of New York. 4000 w. Eng Rec—March 5, 1910. No. 12148.

Experimental Work of the New York State Highway Commission. An account of work to obtain data upon the cost and effectiveness of materials and methods. 2200 w. Eng Rec—March 12, 1910. No. 12246.

Effect of Motor and Horse-Drawn Vehicles on Roads. Logan Waller Page. Read at the Nat. Legislative Con. Discusses the problems that must be met by highway engineers. 2200 w. Eng Rec—Feb. 26, 1910. No. 12031.

Construction and Wear of Roads. Henry Reginald Arnulph Mallock, with abstract of discussion. Discusses foundations, surface, drainage, and formation and diffusion of dust. 20500 w. Inst of Civ Engrs, No. 3826—March 23, 1909. No. 12591 N.

Economics and Principles of Macadam Construction for Towns. D. T. Black. Discusses the serviceable qualities of macadam roads, their construction, and durability. 2500 w. Can Engr—March 4, 1910. No. 12133.

Macadam Roads and Their Preservation. L. W. Page. Discusses road construction and maintenance. General discussion. 12000 w. Jour W Soc of Engrs—Feb., 1910. No. 12557 D.

Tar Macadam and the New "Breining" Mixing Machine (Ueber Teermakadam und eine neue Teermakadammischmaschine, System "Breining"). Karl Breitenfelder. Discusses this road material and describes a new device for mixing and laying. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 19, 1910. No. 12488 D.

Notes on the Use and Cost of Concrete Blocks in Roadway Construction. George C. Wright. Read before the Nat. Assn. of Cement Users. Describes an experimental road built on this system, giving cost. 1000 w. Cement—March, 1910. No. 12671 C.

Dustless Roads. Report of the Royal Automobile Club. 2500 w. Surveyor—March 18, 1910. No. 12725 A.

Some Methods and Costs of Oiling Roads in St. Louis with a Description of a New Construction Employing Molded Slabs of Bitumen and Aggregate. Ills. 1800 w. Engng-Con—March 23, 1910. No. 12576.

Tar-Spraying Devices (Appareils à Goudronner). A. Moreau. A report on the Lassailly system, with details of the machine. Ills. 3000 w. Bul Soc d'Encour—Jan., 1910. No. 12417 G.

The Vinsonneau System of Tar Spraying (Le Système de Goudronnage des Routes par M. J. Vinsonneau). A. Moreau. Describes the machine and discusses the system. Ills. 2700 w. Bul Soc d'Encour—Jan., 1910. No. 12418 G.

Sanitation.

Progress of Sanitary Reform. H. T. Wakelam. Presidential address before the Institute of Sanitary Engineers on the advance of sanitation. Short discussion 5500 w. Surveyor—Feb. 25, 1910. No. 12183 A.

Sewage Disposal.

The Stumbling Block in Sewage Purification and the Means of Overcoming It (La Pierre d'Achoppement de l'Epuration des Eaux d'Egout et le Moyen de la Tourner). A. Puech. Discusses the difficulties in dealing with suspended matter in sewage and outlines various solutions of the problem. Ills. 6000 w. Bul Soc d'Encour—Jan., 1910. No. 12419 G.

Sewage Treatment to Prevent River Pollution. A statement by George A. Johnson at the convention of the Indiana Sew. & Water Sup. Assn. A discussion of sewage purification. 2500 w. Eng Rec—March 19, 1910. No. 12365.

Sewage of Ten Million Population. Kenneth Allen. Gives data collected by the New York Bay Pollution Commission concerning conditions attending the disposal of sewage in the metropolitan district. 2500 w. Munic Jour & Engr—March 23, 1910. Serial. 1st part. No. 12542.

The Drainage of a Country House. J. D. Watson. Read before the British Inst. of San. Engrs. Discusses the disposal of sewage from isolated buildings. Ills. 2500 w. Can Engr—March 25, 1910. Serial. 1st part. No. 12672.

Sewage Distribution.

Notes on the Automatic Revolving Sewage-Distributors at the Derby Sewage Disposal Works. Arthur Percy Maddocks. A report of tests. 3500 w. Inst of Civ Engrs, No. 3819—1909. No. 12595 N.

Sewage Distribution Tests at Mount Vernon, N. Y. Charles A. Hammond. An illustrated report of experiments to ascertain the actual discharge of various sizes of cylindrical nozzles, and the relative efficiency of spray distribution by various forms of splash-cups under different conditions. 2500 w. Eng News—March 24, 1910. No. 12583.

Sewage Testing.

The Sewage Testing Station of the Sanitary District of Chicago. Langdon Pearse. An account of the study of the sewage problem in Chicago to obtain data regarding the cheapest and best plan for increasing the present facilities for sewage development. Ills. 5000 w. Eng News—March 31, 1910. No. 12777.

Sewer Pipe.

Cement Pipe for Sewer Purposes. O. U. Miracle. Read before the N.-W. Cement Products Assn. Briefly discusses the principal objections raised, showing them to be groundless. 1200 w. Cement Age—March, 1910. No. 12543.

Sewers.

Some Points for Consideration in the Sewering of Small Towns. Henry C. Adams. Discusses the capacity of sewers, gradients, size of pipes and joints, tests, manholes, ventilation, etc. 3000 w. Surveyor—March 4, 1910. No. 12284 A.

A Large Storm Sewer Supported on Piers. A reinforced-concerte sewer in Philadelphia is illustrated and the construction described. 1300 w. Eng Rec—March 19, 1910. No. 12371.

See also Reinforced Concrete, under BRIDGES.

Snow Removal.

Method and Cost of Snow Removal in St. Louis, Mo., by Flushing It Through the City Sewers. Illustrated description. 900 w. Engng-Con—March 30, 1910. No. 12765.

Surveying.

See same title, under MEASUREMENT.

WATER SUPPLY.

Analysis.

The Sanitary Examination of Water. L. K. Russell, in the *Clarkson Bul.* Considers examinations necessary to insure a safe water for domestic use. 2500 w. Engng-Con—March 23, 1910. No. 12577.

Aqueducts.

The Grindleford to Rowsley Section of the Derwent Aqueduct. Alex. H. Jameson. Illustrated description of "Contract B," covering this portion of the work. Plate. 2200 w. Engr, Lond—March 4. 1910. No. 12292 A.

Concrete Arch Tests—Medina Aqueduct. Explains the necessity of constructing this aqueduct and the selection of a concrete arch of single span as the type, and describes extensive tests on concrete prisms and model arches for the purpose of obtaining information for this important work. Ills. 3500 w. Barge Canal Bul—Feb. 1910. No. 12317 N.

Tests of Models of the Medina Aqueduct Arch. From advance sheets of the *Barge Canal Bulletin.* An illustrated account of tests made to obtain information concerning the behavior of concrete under certain conditions of stress, in connection with the design of probably the most important piece of concrete arch construction yet undertaken. 3500 w. Eng Rec—March 5, 1910. No. 12140.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Columbus, O.

The Improved Water and Sewage Works of Columbus, Ohio. Discussion of the paper by John H. Gregory. 11000 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12710 E.

Dams.

Plans and Specifications for Early Timber, Earth and Masonry Dams Built in Connecticut. Illustrates and describes dams designed by Harry T. Potter, three built between 1860 and 1870, and nine built between 1881 and 1891, as described in a paper by C. E. Chandler, read before the Conn. Soc. of Civ. Engrs. 5000 w. Engng-Con—March 9, 1910. No. 12199.

Concrete and Masonry Dam-Construction in New South Wales. Leslie Augustus Burton Wade, with abstract of discussion. Illustrated detailed description of certain dams constructed for storing water. 48500 w. Inst of Civ Engrs, No. 3791—March 9, 1910. No. 12590 N.

Building the Olive Bridge Dam for the Catskill Water Supply. Illustrated description. 1500 w. Sci Am—March 19, 1910. No. 12348.

Description of the New Dam and Pumping Station Built by the City of Peterborough, Ont. A. W. Ellson Fawkes. Illustrated description of the work. 1600 w. Can Engr—March 4, 1910. No. 12132.

The Shut-Off Dam at the Charles River Basin. James W. Rollins, Jr. A critical discussion of the plans submitted, describing the design finally constructed. Ills. General discussion. 7500 w. Jour Assn of Engng Socs—Jan, 1910. No. 12570 C.

The Movable Dam Across the Red River at St. Andrew's Rapids. H. P. Borden. Explains the conditions and describes the solution of the problem by the construction of a Caméré curtain dam, the first constructed on the American continent. Ills. 5000 w. Eng Rec—March 26, 1910. No. 12660.

Partial Failure of a Concrete Dam at Austin, Pa. General plans and detailed description of the concrete dam for the Bayless Pulp & Paper Co., with an account of the trouble. 2500 w. Eng News—March 17, 1910. No. 12316.

Fishways (Ueber Anlage von Fischpässen). S. Bitterli. Discusses their design, illustrating types. 2200 w. Schweiz Bau—Feb. 12, 1910. No. 12476 B.

Diversion Damages.

The Underlying Principles Governing Riparian Water Rights and Diversion Suits. Charles F. Choate, Jr., with discussion. Explains the nature of the right the riparian owner possesses. 7000 w. Jour N Eng W-Wks Assn—March, 1910. No. 12597 F.

Report of Committee Appointed to Collect Data Relating to Awards for Water and Water-Power Diversion. Explains methods and value of data, the approximate power derivable from New England watersheds, and related information, with bibliography. 45000 w. Jour N Eng W-Wks Assn—March, 1910. No. 12596 F.

E. P. and S. Railway.

The Water Supply of the El Paso and Southwestern Railway from Carrzozo to Santa Rosa, N. Mex. J. L. Campbell. Describes the supply serving the division named, a distance of 128 miles. Ills. 7200 w. Pro Am Soc of Civ Engrs—March, 1910. No. 12707 E.

Fire Protection.

Fire Wastes. Herbert M. Wilson. Discusses the enormous fire losses in the United States and its relation to the water supply. Discussion. 3500 w. Pro Am W-Wks Assn—1909. No. 12752 N.

Toronto High Pressure Fire System. C. L. Fellows. Illustrated description. 1200 w. Pro Am W-Wks Assn—1909. No. 12759 N.

The High Pressure Fire System of Baltimore. Raymond Schlegel. Describes the high pressure fire line under construction. 2000 w. Cornell Civ Engr—March, 1910. No. 12545 C.

Factories and Their Fire Protection. Franklin H. Wentworth. An illustrated article explaining certain fundamental principles to be kept in mind in planning a factory, and describing details. 2500 w. Archt Rec—March, 1910. No. 12021 C.

Ground Waters.

Observation and Investigation of Ground-Water Sources (Beobachtung und Ermittlung von Grundwasserständen und Strömungen). Rudolf Müller. Describes a simple device for investigation at depths of one or two metres beneath the surface. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 19, 1910. No. 12489 D.

The Computation of Ground Water Supplies (Contributo alla Teoria delle Falde idriche nei Terreni permeabili). Carl Fossa-Mancini. A mathematical discussion, including consideration of rainfall. Ills. 7000 w. Ann d Soc d Ing e d Arch Ital—Feb. 1, 1910. No. 12444 F.

Hydrants.

Progress Report of the Committee on Proposed Specifications for Post Hydrants. Discussion. 5500 w. Jour N Eng W-Wks Assn—March, 1910. No. 12598 F.

Irrigation.

Irrigation in Turkey (L'Irrigation en Turquie). Louis Godard. A review of the irrigation projects of the Turkish government. Ills. 4000 w. Génie Civil—Feb. 12, 1910. No. 12439 D.

Liverpool.

Completion of Liverpool Water-Works at Vyrnwy. First article of a series describing in detail the great Welsh water scheme for the supply of Liverpool. Ills. 1200 w. Engr, Lond—March 18, 1910. Serial. 1st part. No. 12741 A.

Mexico.

Water Problems in Mexico. Edward Bartow. An illustrated explanation of conditions and the work accomplished. 1200 w. Pro Am W-Wks Assn—1909. No. 12760 N.

Pipe Corrosion.

Action of St. Louis Water on Metals and Alloys. Abstract of a paper by W. F. Monfort before the Illinois Water Supply Assn. describing the action of chemically treated water upon the metal of the distribution system. 3000 w. Eng Rec—March 19, 1910. No. 12366.

Pipe Failures.

A Break in a Water Main at Springfield, Mass. Elbert E. Lochridge. Brief account of the accident and its consequences. 700 w. Eng News—March 31, 1910. No. 12781.

Purification.

The Development of the Water Supply at Superior, Wisconsin, with Special Reference to the Iron Removal Plant Now in Operation. William C. Lounsbury. An illustrated account of the water supply of Superior. 3000 w. Pro Am W-Wks Assn 1909. No. 12754 N.

Reforestation.

Reforestation of the Marginal Lands of the Wachusett Reservoir of the Metropolitan Water Works, Boston, Mass. E. R. B. Allardice. Outlines the general plan adopted and describes the work of raising from seed the trees to be used in the field and the improvement and protection on existing forests. Ills. Discussion. 10000 w. Jour Assn of Engng Socs—Jan, 1910. No. 12572 C.

Reservoirs.

See Roofs, under CONSTRUCTION; and Reforestation, under WATER SUPPLY.

Tanks.

A Water Tank with a Dome Supported Bottom. Brief illustrated description of a novel tank recently built in Mexico. It is of reinforced concrete carried on a circular rubble wall with a novel type of floor construction. 1000 w. Eng Rec —Feb. 26, 1910. No. 12029.

Some Methods and Cost of Building Reinforced Concrete Cisterns. Benjamin Brooks. Plan and description of reinforced-concrete cisterns for water storage, San Francisco, Cal. 2500 w. Engng-Con —March 30, 1910. No. 12766.

Wastes.

Waste Water Survey, City of Chicago. T. C. Phillips. Explains the methods of investigation. Discussion. 7500 w. Pro Am W-Wks Assn—1909. No. 12751 N.

Water Towers.

A Concrete Water Tower. A. Kempkey, Jr. Illustrated description of an elevated tank of novel design for the water works system of the city of Victoria, B. C., with the reasons for adopting the type of structure used, the method of construction and cost. 3000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12653 E.

Water Works.

Braintree Water-Works Extension. Brief description of the work completed in connection with an important scheme of extensions. The deepening of an old well and the installation of new pumping machinery. 1500 w. Eng., Lond—Feb. 25, 1910. No. 12195 A.

Water-Works Valuation.

The Necessary Elements for Water-Works Valuation. John W. Alford. Read before the Indiana San. & Water-Suply Assn. Outlines four methods of valuing public utility property which have been upheld by the courts, and discusses in detail the valuation by reproduction. 2500 w. Eng News—March 10, 1910. No. 12217.

Notes on Going Value and Methods for Its Computation. John W. Alvord. Discusses the theory of valuation by reproduction. General discussion follows. 32600 w. Pro Am W-Wks Assn—1909. No. 12753 N.

Weirs.

A New Type of Weir Construction (Das Kragnadelwehr). Otto Felix Schossberger. A detailed mathematical discussion of the design of a new type of needle weir. Ills. Serial. 1st part. 5000 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 5, 1910. No. 12487 D.

WATERWAYS AND HARBORS.

Barge Canal.

Rapid Progress of the New York State Barge Canal. Illustrated report of recent work. 800 w. Sci Am—March 5, 1910. No. 12069.

Bulkheads.

The Sea Wall in Connection with Buildings. George A. Orrok. Read before the Conn. Soc. of Civ. Engrs. Describes a number of bulkhead constructions that have been used with success, stating difficulties encountered and approximate costs. Ills. 2200 w. Eng Rec—Feb. 26, 1910. No. 12032.

Canal Regulators.

Collapse of an Important Canal Head Sluice in Egypt. Sir Hanbury Brown. Illustrated account of the wreck of the Menufia head regulator on Dec. 26, 1909. 2500 w. Engr, Lond—March 18, 1910. No. 12738 A.

Canals.

See Barge Canal, under WATERWAYS AND HARBORS.

Dredges.

Clay-Cutting Suction Dredger for Auckland, N. Z. Illustrated description of a recently built pontoon suction dredge for deepening Auckland harbor and reclaiming land at that port. 500 w. Engr, Lond—March 11, 1910. No. 12503 A.

See also Dredging, under ELECTRICAL ENGINEERING, POWER APPLICATION.

Flood Protection.

The Protection and Drainage of Lands Subject to Overflow. Notes from a paper by C. W. Brown before the Ills. Soc. of Engrs. & Survs. Discusses the design and construction of such works. 3300 w. Eng Rec—Feb. 26, 1910. No. 12033.

Floods.

The Engineering Features of the Recent Floods in Paris. Explains conditions that caused the floods, giving a record of the height in Paris and the damage. Ills. 4500 w. Eng News—March 24, 1910. No. 12582.

The Seine Flood of January, 1910 (La Crue de la Seine, de Janvier, 1910). A. Dumas. A review of the history of the flood, profusely illustrated. 9000 w. Génie Civil—Feb. 5, 1910. No. 12436 D.

Fighting the Paris Flood. Warren H. Miller. Describes the floor, the problems to be met, and the methods used in solving them. Ills. 3000 w. Eng Rec—Feb. 26, 1910. No. 12025.

Cause and Remedies of the Seine Floods (Les grandes Crues de la Seine, Causes et Remèdes). C. Boutillier. A study of the problems presented by the recent flood. 5000 w. Tech Mod—Feb., 1910. No. 12426 D.

France.

The Inland Waterways Propaganda in France. Explains how the waterways development was brought about, and the attitude of the government. 2000 w. Eng News—March 24, 1910. No. 12587.

Locks.

The Locks and Gates of the Panama Canal. Map and plate with illustrated description of the structures and explanation of the principles governing their design. 6500 w. Eng Rec—Feb. 26, 1910. No. 12024.

Panama Canal.

The Real Status of the Panama Canal as Regards Neutralization. H. S. Knapp. Discussion regarding freedom of passage and inviolability in war, stating facts and conclusions favoring its being fortified and garrisoned. 15800 w. Pro U S Nav Inst—March, 1910. No. 12537 F.

See also Locks, under Waterways and Harbors.

Piers.

The Chelsea Section Improvement—A Municipal Enterprise. Illustrated description of the mine piers extending from Little West Twelfth Street to West Twenty-second Street, on the North River, New York City. A bulkhead wall of concrete and masonry, pier sheds, and their equipment. 1500 w. Archts & Bldrs' Mag—Feb., 1910. No. 12210 C.

Structural Features of New Concrete Recreation Pier at Albany, N. Y. Illustrated description of a new recreation and boat pier being constructed after designs by Walter Melius. 700 w. Engng-Con—March 23, 1910. No. 12574.

Pollution.

See Coke-Oven Effluents, under MINING AND METALLURGY, Coal and Coke.

River Regulation.

Regulation of the Lower Elbe from Hamburg to Brunshausen (Regulierung der Unterelbe von Hamburg bis Brunshausen). A. v. Horn. Describes methods, cost, etc. Ills. 6500 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 26, 1910. No. 12490 D.

Sea-Water Freshening.

Distribution of Sea Water in the Charles River Basin After Excluding Tidal Waters. Morton F. Sanborn. Investigations to determine the rate of freshening and study of the circulation are described. 2500 w. Eng News—March 10, 1910. No. 12214.

Stream Flow.

The Relation of Forests to Stream Flow. Maj. William W. Harts. From Prof. Mem., Engrs.' Bureau, U. S. Army. Reports a study of the Cumberland and the Tennessee rivers which refutes statements regarding deforestation and navigation. Also a letter from R. C. Beardsley and editorial. 6500 w. Eng News—March 3, 1910. No. 12109.

U. S. Waterways.

Light from Europe on Proposed Waterway Development in the United States. Editorial on the report by W. H. Lindley dealing with European waterways, comparing with report regarding the Mississippi and its tributaries. 1800 w. Ry Age Gaz—March 25, 1910. No. 12639.

Water Powers.

The Evaluation of Water Rights. Arthur Halsted. Gives a method of evaluating a water right which is applicable to a special case of an undeveloped, or partially developed water power. 3000 w. Eng Rec—Feb. 26, 1910. No. 12028.

MISCELLANY.

Caisson Disease.

Caisson Disease. Editorial on an investigation of the Admiralty Committee. 2200 w. Engng—Feb. 18, 1910. No. 12063 A.

U. S. Reclamation Service.

Extracts from the Testimony of Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service, before the Committee to Investigate the Interior Department and Forestry Service. 3500 w. Eng News—March 31, 1910. No. 12780.

Wood Refuse.

An Important Development in the Utilization of Wood Refuse. Walter E. Truesdell. Describes a plant being built at Hadlock, Washington, for producing ethyl alcohol on a commercial scale, and explains use of the residue. 2500 w. Cornell Civ Engr—March, 1910. No. 12546 C.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy and Telephony. Cornelius D. Ehret. A review dealing only with wireless telegraphy and wireless telephony employing electro-magnetic waves. Short discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12565 D.

The Radiation from Directive Aerials in Wireless Telegraphy. L. H. Walter. Deals with the question of dirigibility in the emission of electric waves, taking into account the methods of Artom, and of Bellini and Tosi. 2000 w. Elect'n, Lond—Feb. 25, 1910. No. 12177 A.

Joint Navy and Fessenden Long-Distance Wireless Tests. An account of tests made and to be made in the interest of the U. S. Navy Department, especially with the Fessenden apparatus. 2000 w. Elec Wld—March 31, 1910. No. 12628.

Radiotelephony.

The Collins Long-Distance Wireless Telephone. William Dubilier. Illustrated detailed description. 1000 w. Elect'n, Lond—March 4, 1910. No. 12281 A.

See also Radiotelegraphy, under COMMUNICATION.

Telephony.

The Early Days of the Telephone. Facts from the testimony of Theodore N. Vail before a joint committee of the N. Y. State Legislature. 6500 w. Elec Rev, N Y—March 5, 1910. No. 12163.

Telephone Circuits. Prof. J. Perry. Abstract of a paper before the Physical Society, with remarks of interest by Major O'Meara and A. W. Martin in connection with the Post-Office telephone cables. 4500 w. Elect'n, Lond—March 11, 1910. No. 12330 A.

Telephotography.

The Sémat System of Telephotography (Le Téléautocopiste Sémat). M. de Kermond. Illustrated description. 2000 w. L'Elecn—Feb. 5, 1910. No. 12427 D.

DISTRIBUTION.

Condensers.

Tubular Electric Condensers. A. D. Budd. Illustrates and describes a process of producing condensers from paper, soaked with a well-adhering insulating varnish. 1200 w. Elec Wld—March 24, 1910. No. 12580.

Fuses.

An Investigation of the Fusing of Silver, Copper, and Lead Wires in Porcelain Tube Cartridges (Abschmelzversuche mit Silberdrähten, Kupferdrähten und Bleidrähten in Porzellan-Rohrpatronen). Robert Edler and Robert Schuster. Describes the tests and reports results. Ills. Serial. 1st part. 2000 w. Elektrotechniker—Feb. 10, 1910. No. 12497 D.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Design of Turbo Field Magnets for Alternate-Current Generators with Special Reference to Large Units at High Speeds. Miles Walker. Re-opens the controversy between the salient pole type and the cylindrical type, giving reasons why the latter is better suited for obtaining the greatest possible output from a given diameter. Ills. 3500 w. Inst of Elec Engrs—March 10, 1910. No. 12716 N.

Armature Reaction and Compounding of Alternators. J. E. Dalemont and L. A. Herdt. Discusses the causes of drop in alternators, and explains two methods of compensation. 2200 w. Elect'n, Lond—March 11, 1910. No. 12331 A.

Short-Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings. Miles Walker. Deals with the currents which flow when large electric generators are short-circuited. Ills. 5000 w. Inst of Elec Engrs—March 8, 1910. No. 12328 N.

Voltage Regulation of Alternators. Burton McCollum. Explains methods of determining the regulation of an alternator. 3300 w. Bul Univ of Kansas, No. 1—Nov., 1909. No. 12650 N.

A. C. Motors.

Discussion on "On the Space Economy of the Single-Phase Series Motor," New York, January 14, 1910. Discussion of paper by William S. Franklin and Stanley S. Leyfert. 5000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12705 F.

Commutation.

Commutation. F. W. Carter. A discussion of resistance and reactance of coil circuits during the commutating period. Also editorial note. 3000 w. Elec Wld—March 31, 1910. No. 12627.

Failures.

Lessons of Some Motor and Dynamo Failures. Howard S. Knowlton. Explains causes of trouble. 1800 w. Power—March 8, 1910. No. 12171.

Heating.

The Influence of Ventilation on the Temperature of Bare or Insulated Conductors (De l'Influence de la Ventilation sur la Température de Régime des Conducteurs nus ou isolés). Louis Roy. Mathematical discussion. 4000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12410 F.

Induction Motors.

The Operation of Single-Phase Induc-

We supply copies of these articles. See page 317.

tion Motors (Die Wirkungsweise des einphasigen Induktionsmotors). Gustav Benischke. Mathematical discussion of induction-motor characteristics. Ills. 3200 w. Elec Kraft u Bahnen—Feb. 4, 1910. No. 12499 D.

Motor Converters.

The Cascade Converter (Der Kaskadenumformer). H. S. Hallo. A practical discussion of its operation. Ills. 4000 w. Elek Kraft u Bahnen—Feb. 14, 1910. No. 12600 D.

Motor Generators.

Motor-Generator Sets of 3000 Kilowatts Maximum Continuous Rating. David Hall. Illustrated descriptions of recent designs. 1200 w. Elec Jour—March, 1910. No. 12314.

Speed Regulation.

The Routin Automatic Governor for Alternators, Turbines, etc. (Régulateurs automatiques, système J. L. Routin applicables aux Alternateurs, Turbines, etc.). Illustrated description of the governor and its application. 2500 w. L'Elecn—Feb. 26, 1910. No. 12431 D.

A New System of Governing Three-Phase Motors and a Comparison with Systems Hitherto Used (Ein neues System regelbarer Drehstrommotoren und ein Vergleich desselben mit bisher angewandten Systemen zum Regeln der Umlaufzahl elektrischer Motoren). A. Scherbius. Detailed description. Ills. Serial. 1st part. 2600 w. Elek Kraft u Bahnen—Feb. 24, 1910. No. 12602 D.

Standardization.

Some Notes on Standardization of Electrical Machines. R. Orsettich. Discusses the arrangements generally adopted in the manufacture of dynamo-electric machinery. 4500 w. Elect'n, Lond—March 11, 1910. No. 12329 A.

Stray Currents.

The Genesis and Avoidance of Stray Currents in Machine Frames (Entstehung und Vermeidung von Lagerströmen). Leonhard Adler. Discusses their cause and means for avoiding currents through the axle, bearings and base plates of electrical machines. Ills. 4100 w. Elektrotech u Maschinenbau—Feb. 20, 1910. No. 12624 D.

ELECTRO-CHEMISTRY.

Cells.

On Cadmium Amalgams and the Weston Normal Cell. F. E. Smith. Abstract of a paper read before the Physical Soc. Describes researches with chilled and slowly cooled amalgams containing from 1 to 25 per cent of cadmium. 3500 w. Elect'n, Lond—March 18, 1910. No. 12720 A.

Corrosion.

See Boiler Corrosion, under MECHANICAL ENGINEERING, Steam Engineering.

Electric Furnaces.

The Proportioning of Electrodes for Furnaces. Carl Hering. A study of the principles underlying the proper proportioning of electrodes. A review of investigations. 15000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12703 F.

Properties and Behavior of Furnace Electrodes. Carl Hering. Examines, by analogy, the changes in the behavior of the electrodes caused by the different physical properties and temperature variations. 3000 w. Met & Chem Engng—March, 1910. No. 12205 C.

On the Modifications in Hering's Laws of Furnace Electrodes Introduced by Including Variations in Electric and Thermal Resistivity. A. E. Kennelly. Considers, from an arithmetical point of view, how far the temperature variation in electric and thermal resistivities of the electrodes modifies these laws. 3000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12702 F.

Electroplating.

The Management and Analysis of Silver Plating Solutions in Germany; and the Use of Barium Cyanide for Their Regeneration. B. Wenzelmann. Directions to enable the silver plater to control and analyze his cyanide silver solutions without the assistance of a chemist. 2000 w. Brass Wld—March, 1910. No. 12541.

Nitrogen.

The Reduction of Atmospheric Nitrogen. Illustrates and describes the Schönherr process. 1200 w. Sci Am Sup—March 12, 1910. No. 12225.

Ozone.

The Uses of Ozone: The Ozonair System. Illustrates and describes the portable ozone generators and the system developed by E. L. Joseph. 1000 w. Elec Rev, Lond—March 18, 1910. No. 12715 A.

Review of 1909.

Electrochemistry and Electrometallurgy in 1909. Dr. F. Mollwo Perkin. A review of progress. 6000 w. Elect'n, Lond—March 18, 1910. No. 12719 A.

ELECTRO-PHYSICS.

Conservation of Energy.

The Law of Conservation of Energy. Dr. Charles P. Steinmetz. Calls attention to the uses of this law for engineering purposes. 4500 w. Jour W. Soc of Engrs—Feb., 1910. No. 12558 D.

Current Rectifiers.

Crystal and Solid Contact Rectifiers. A. E. Flowers. Abstract of an article in the *Phys. Rev.* Describes the characteristics of the galena rectifier, and the artificial production of rectifiers by chemical and electrochemical treatment, discussing results. 1800 w. Elect'n, Lond—Feb. 18, 1910. No. 12055 A.

See also Oscillograph, under Measurement.

Electric Waves.

Electric Waves and the Electromagnetic Theory of Light. Abstract of the first three lectures given by Prof. Sir Joseph J. Thomson at the Royal Institution. 2500 w. Elect'n, Lond—March 4, 1910. Serial. 1st part. No. 12280 A.

Electric Waves and the Electromagnetic Theory of Light. Editorial review of Sir J. J. Thomson's lecture on this subject. 2500 w. Engng—March 18, 1910. No. 12735 A.

Production, Measurement, and Effect of Variable Wave-Form. Lancelot W. Wild. Communicated to the Inst. of Elec. Engrs. Describes the author's means of varying the wave-form, and for measuring its characteristics, giving results of tests. 7500 w. Elec Engr, Lond—Feb. 18, 1910. No. 12050 A.

Hysteresis.

Effect of Temperature on the Hysteresis Loss in Iron in a Rotating Field. W. P. Fuller and H. Grace. Abstract of paper read before the Phys. Soc. A report of experimental investigations. 700 w. Elect'n, Lond—Feb. 25, 1910. No. 12179 A.

Induction.

On the Law of Induction (Sur la Loi de l'Induction). M. de Baillehache. A comprehensive theoretical discussion. Ills. 13000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12412 F.

Induction Coils.

Teaching the Theory of an Alterating-Current Circuit Surrounding an Iron Core (Pädagogisches zur Theorie des eisenumschlingenden Wechselstromkreises). Carl Breitfeld. Discusses the best method of teaching the theory of cyclic magnetization. Ills. 2800 w. Elektrotech u Maschinenbau—Feb. 6, 1910. No. 12625 D.

Magnetic Properties.

The Magnetic and Electrical Properties of Iron—Silicon Alloys. Charles F. Burgess and James Aston. Reports an investigation covering tests of 15 iron-silicon alloys, discussing results. 1000 w. Met & Chem Engng—March, 1910. No. 12206 C.

GENERATING STATIONS.

Balancers.

Balancers for Three-Wire Systems. A. G. Cooper. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. Describes the well known forms of continuous-current balancers and also discusses static balancers, giving particulars of some tests. General discussion. 2200 w. Elect'n, Lond—Feb. 25, 1910. No. 12178 A.

Central Stations.

Central Stations for Towns of 1000 Population. Caryl D. Haskins. Information as to cost of installations and operations of electrical plants for towns from 500 people, upward. 3500 w. Munic Engng—March, 1910. No. 12327 C.

Electrical Plant of the Hudson and Manhattan Railroad Company. Illustrates and describes the generating and distributing systems of the McAdoo Hudson River tunnels. 1200 w. Elec Wld—March 3, 1910. No. 12102.

Power Station of the Hudson & Manhattan Railroad. Hugh Hazelton. Illustrated detailed description, with editorial. 4000 w. Elec Ry Jour—March 5, 1910. No. 12134.

Merchants Heat and Light Company. Illustrated description of the application of the steam turbine for lighting and exhaust steam heating at Indianapolis, Ind. 1500 w. Elec Wld—March 17, 1910. No. 12376.

New Power Plant of the Merchants Heat and Light Company, Indianapolis. Illustrated description of a modern central station. 3000 w. Elec Rev, N Y—March 5, 1910. No. 12162.

New High-Tension Electric Generating Station, Dundee. Illustrated detailed description of the station furnishing power for this city in Scotland. 4000 w. Engng—March 18, 1910. No. 12731 A.

The Electrical Plants of the Hannover Street Railways (Die elektrischen Anlagen der Strassenbahn Hannover, insbesondere deren Betrieb als Ueberlandzentrale). B. Urbach. Details of the five generating stations and the four substations. Ills. Serial. 1st part. 2500 w. Elek Kraft u Bahnen—Feb. 14, 1910. No. 12601 D.

Costs.

Cost of Production in Four Central Stations. Gives detailed records of cost for four properties in Massachusetts. 1200 w. Elec Wld—March 31, 1910. No. 12769.

The Consumption of Coal per Kilowatt-Hour in Central Stations (Le Centrali termoelettriche ed il Consumo di Carbone per kw.-Ora). Guiseppe Belluzzo. A discussion of the importance of the fuel item in the cost of electric power. Ills. 3700 w. Industria—Feb. 20, 1910. No. 12450 D.

Economics.

Ice Making and Steam Heating by Small Central Station. Detailed analysis of the methods employed to obtain the maximum return on the investment. Ills. 2500 w. Elec Wld—March 3, 1910. No. 12103.

Central Station Economies. W. L. Abbott. Reviews the progress in methods of generating and distributing electrical energy, and considers the important economies. Discussion. 7500 w. Jour W Soc of Engrs—Feb., 1910. No. 12556 D.

Hydro-Electric.

A General Review of Hydroelectric-Engineering Practice. Frank Koester. Discusses the economic and engineering aspects of the impounding of water powers. First article of a series. Ills. 5000 w. Engineering Magazine—April, 1910. No. 12683 B.

Operations of Hydroelectric Plants. Alton D. Adams. Discusses the advantages attending the storage of water for use as needed. 1400 w. Elec Wld—March 24, 1910. No. 12579.

Electric Power Development on the Los Angeles Water-Supply Aqueduct. Gives the findings reported by the Board of Consulting Engineers as the result of a preliminary study. Map. 3000 w. Eng News—March 24, 1910. No. 12585.

Hydroelectric Plant, with Storage. R. A. Lundquist. Illustrated description of a 46000-volt system of the La Crosse, Wis., Water-Power Co. 3000 w. Elec Wld—March 31, 1910. No. 12626.

The Nisqually Hydro-Electric Plant of the City of Tacoma, Washington. Plans and description of a $2,000,000 municipal power plant. 1500 w. Eng News—March 17, 1910. No. 12307.

The Construction of the Rainbow Falls Hydroelectric Development. Illustrated description of this development on the Missouri River, near Great Falls, Montana. 6000 w. Eng Rec—March 12, 1910. No. 12239.

Distribution System of the Southern Power Company. J. W. Fraser. An illustrated article giving a summary of generating stations, substations, and transmission lines, with a description of recent 100,000-volt work. 1500 w. Elec Wld—March 24, 1910. No. 12578.

The Bear River Plant of the Telluride Power Company. Outlines the system of this company, giving an illustrated detailed description of the development near Grace, Idaho. 3500 w. Eng Rec—March 26, 1910. No. 12661.

The Mexico Light & Power Co.'s Electric Plant. H. E. West. Illustrated detailed description of the Necaxa plant. 3000 w. Min Wld—March 5, 1910. No. 12150.

The Refrain Power Plant (L'Usine du Refrain). Illustrated description of an important plant in Switzerland. Serial. 1st part. 500 w. Bul Tech d l Suisse Romande—Feb. 10, 1910. No. 12424 D.

Madrid.

The Electrical Industries in Madrid (Las Industrias electricas en Madrid). Severo Gomez Nunez. A brief review of the generating stations in Madrid. Serial. 1st part. 2800 w. Energia Elec—Feb 10, 1910. No. 12451 D.

Power Factor.

Power Factor Correction. Shows the cause of phase displacement between the current and pressure and the detrimental effects upon the working of the plant, discussing what can be done to correct the trouble. 4400 w. Engr, Lond—Feb. 25, 1910. Serial. 1st part. No. 12193 A.

Protective Devices.

The Protection of Electrical Plants Against Dangerous Rises of Tension (La Protezione degli Impianti elettrici contro le Sopratensioni pericolose per il Pubblico). Vittorio Barassi. Discusses causes of, and methods of protection against, sudden rises of voltage. Ills. Serial. 1st part. 2500 w. Industria—Feb. 6, 1910. No. 12449 D.

Rates.

British Central-Station Rates. Francis H. Davies. Brief account of the different systems of charging and the movement toward standardization in method of charge. 2000 w. Elec Wld—March 10, 1910. No. 12202.

"Reasonable Rates" for Gas and Electricity as Determined by the Wisconsin Railroad Commission for the City of Madison. Gives the method of valuation and related investigations. 5000 w. Eng News—March 31, 1910. No. 12779.

Commercial Motor Service Rates and Their Effect on Station Economy. A. E. Walden. Suggestions on the development of the business prospects of motor service, the type of motor, the question of rating, etc. 2500 w. Elec Wld—March 3, 1910. No. 12104.

Taxes.

Taxes on Electricity (Steuer auf Elektrizität). Heinrich Schreiber. A criticism of recent legislation in Germany and Austria. 6000 w. Elektrotech u Maschinenbau—Feb. 13, 1910. No. 12604 D.

LIGHTING.

Arc Lamps.

The Stave Flaming Arc Lamp. Illustrated description of one of the new high efficiency lights of alternating-current type. 1500 w. Ir Age—March 31, 1910. No. 12784.

Illumination.

Graphical Method of Solving Certain Problems in Illuminating Engineering. Albert F. Parks. Gives diagram and chart with explanation. 1500 w. Elec Wld—March 24, 1910. No. 12581.

Quality of Light. Paul F. Bauder. A study of illumination concluding that the best artificial illuminant is that which is adaptable to the largest number of classes of service, providing its quality is maintained. 4000 w. Jour Fr Inst—March, 1910. No. 12750 D.

Electricity in a Modern Restaurant. T. I. Jones. Illustrates and describes the applications of electricity for illumination and power in the Café de l'Opera, New York. 2000 w. Elec Wld—March 10, 1910. No. 12200.

Incandescent Lamps.

The Electric Incandescent Lamp. James

Findlay. Read at the Birmingham and District Elec. Club. Deals with its construction and application. 4000 w. Elec Engr, Lond—Feb. 25, 1910. No. 12176 A.

Tantalum Filament Characteristics. L. Crouch. Develops a simplified Stefan formula. 700 w. Elect'n, Lond—Feb. 25, 1910. No. 12180 A.

The Tungsten Lamp and Its Relations to Central Stations. George Merrill. Showing the effect of the tungsten lamp and its later developments upon commercial interests. 2500 w. Munic Engng—March, 1910. No. 12326 C.

Metallic-Filament Incandescent Lamps (Les Lampes incandescentes à Filament Métallique). A. Joubert. A review of their development, manufacture, applications, and economy. Ills. 5500 w. L'Elecn—Feb. 19, 1910. No. 12430 D.

Luminous Efficiency.

Luminosity and Temperature. P. G. Nutting. Investigations of the relation of luminous efficiency to temperature. 2000 w. Bul Bureau of Stand—Feb., 1910. No. 12561 N.

Luminous Efficiency of the Firefly. H. E. Ives and W. W. Coblentz. An investigation of the quality of the light emitted by the firefly, and of a fluorescent substance from the firefly. 4000 w. Bul Bureau of Stand—Feb., 1910. No. 12560 N.

Selective Radiation from Various Solids—II. W. W. Coblentz. Records the behavior of representative examples of various groups of chemical compounds. A study of the radiation from minerals and from metals. 4000 w. Bul Bureau of Stand—Feb., 1910. No. 12559 N.

Mercury Vapor.

Quartz-Tube, Mercury-Vapor Lamps. Warren H. Miller. Describes one of these lamps installed in Paris, explaining the operation and giving information. Ills. 1500 w. Elec Wld—March 17, 1910. No. 12378.

The Applications of the Mercury Vapor Lamp (Les Applications de la Lampe à Vapeur de Mercure). A. R. Garnier. Discusses its application to lighting, the production of high-frequency currents, the separation of alternating currents, etc. Ills. Serial. 1st part. 1800 w. L'Elecn—Feb. 26, 1910. No. 12432 D.

Train Lighting.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

MEASUREMENT.

Galvanometers.

A Theoretical and Experimental Study of the Vibration Galvanometer. Frank Wenner. Mathematical. 8000 w. Bul Bureau of Stand—Feb., 1910. No. 12562 N.

Hysteresis Loss.

A Ballistic Electrodynamometer Method of Measuring Hysteresis Loss in Iron. Martin E. Rice and Burton McCollum. Presents a new and accurate method for making tests to predetermine the hysteresis losses in iron. 2500 w. Bul Univ of Kansas, No. 1—Nov., 1909. No. 12599 N.

Instruments.

Alternating-Current Measuring Instruments, with Special Reference to the New Weston Electromagnetic Type. B. A. J. van der Hegge Zijnen. Discusses their theory, design and use. Ills. 12000 w. De Ingenieur—Feb. 19, 1910. No. 12619 D.

Ferrié and Charpentier Two-Pointer Frequency Meters and Ohmmeters (Appareils à deux Aiguilles, Système Ferrié et Charpentier. Fréquencemètres. Ohmmètres). L. Joly. Describes the construction of the instruments and explains their theory. Ills. 3000 w. Bul Soc Int d'Elecns—Feb., 1910. No. 12411 F.

Laboratories.

The Equipment of the Electrical Engineering Laboratories at the Brighton Technical College. H. H. Broughton. Illustrates and describes the machinery installed. 3000 w. Elec'n, Lond—March 4, 1910. No. 12279 A.

The Palmer Physical Laboratory. Howard McClenahan. Illustrated description of the electrical equipment of the building devoted to the use of the departments of physics and electrical engineering at Princeton University. 2200 w. Elec Wld—March 17, 1910. No. 12377.

Motor Testing.

Short-Circuit Tests of Direct-Current Machines (Kurzschlussdauerproben von Gleichstrommaschinen). R. Doczekal. Practical discussion of testing methods. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—Feb. 27, 1910. No. 12607 D.

Oscillograph.

Application of the Oscillograph in Studying the Operation of Mercury Rectifiers. Yasudiro Sakai. An explanation of its usefulness in such study. Diagrams. 2500 w. Elec Jour—March, 1910. No. 12315.

Permeability.

Note on the Use of Kapp's Apparatus for Measuring Permeability of Iron under High Magnetizing Forces. R. Beattie and H. Gerrard. Describes experiments, showing that results do not support those of E. A. Watson. 1800 w. Elect'n, Lond—Feb. 18, 1910. No. 12054 A.

Wave Form.

The Production, Measurement and Effect of Variable Wave-Form. Lancelot W. Wild. Abstract of a communication to Inst. of Elec. Engrs. Describes the apparatus used for obtaining various wave-forms, and the methods adopted. Also gives tests. 3000 w. Elect'n, Lond—March 14, 1910. No. 12278 A.

POWER APPLICATIONS.

Dredging.

Electricity in Dredging on Puget Sound. Allen E. Ransom. Illustrated description of the electrically driven suction dredge named the "Washington" and its work in the Puyallus River. 1400 w. Elec Jour—March, 1910. No. 12312.

TRANSMISSION.

Balancers.

See same title, under Generating Stations.

Conduits.

Electrical Conduit Construction. Illustrates and describes examples of recent practice. 1500 w. Elec Rev, N Y—March 26, 1910. No. 12669.

Underground Conduit. Paul W. England. Brief description of early forms laid in Philadelphia, and the changes in construction methods from time to time. Present practice and special cases are described in detail. Ills. Short discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12566 D.

High Tension.

See Hydro-Electric, under Generating Stations.

Insulators.

See Protective Devises, under Transmission.

Lightning Protection.

Elan Valley Works: Protection from Lightning. Sir Oliver Lodge. Reports on examination of water-works to determine possible danger from lightning and how best to ensure protection. 3500 w. Elec Engr, Lond—March 4, 1910. No. 12277 A.

See also Signalling, under RAILWAY ENGINEERING, Conducting Transportation.

Line Design.

Economics of Feeder Calculation. H. B. Gear. Method of determining the probable annual loss, based on an analysis of the load curves, and on the development of a formula. 4000 w. Elec Age—March, 1910. No. 12680.

Poles.

See Timber Preservation, under CIVIL ENGINEERING, Materials of Construction.

Protective Devices.

A Practical Method of Protecting Insulators from Lightning and Power Arc Effects. L. C. Nicholson. Relates the experiences and experiments leading to the protective measures adopted on the 6000-volt transmission line of the Niagara, Lockport and Ontario Power Co. from Niagara Falls to Syracuse and other cities. Ills. 5500 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12701 F.

Transformers.

Special Transformers. Norman G. Meade. Discusses briefly three-phase transformers, constant-current transformers and potential regulators. 800 w. Power—March 29, 1910. No. 12746.

Large Artificially Cooled Transformers. Edwin R. Pearson. Describes recent developments in the design and manufacture of transformers of this type. 2500 w. Elec Wld—March 10, 1910. No. 12201.

Voltage Regulation of Stationary Transformers. E. H. Acton. Derives formulas for calculating regulation, showing that in general commercial designs the regulation is practically independent of the exciting current. 1200 w. Elec Wld—March 17, 1910. No. 12379.

MISCELLANY.

Electric Clocks.

Modern Electric Time Service. F. Hope-Jones. Abstract of paper before the Inst. of Elec. Engrs. Discusses only circuits of electrically propelled dials, describing the various systems and presenting interesting oscillograph records. 2200 w. Elect'n, Lond—Feb. 18, 1910. Serial. 1st part. No. 12053 A.

Germany.

The State of the Electrical Industry in Germany in 1909. Dr. R. Bürner. Abstract of an article in the *Elektrotechnische Zeit.* Information relating to the various branches. 2000 w. Elect'n, Lond—March 18, 1910. No. 12718 A.

INDUSTRIAL ECONOMY.

China.

The Industrial Awakening of China (Die Industrialisierung Chinas). Waldemar Koch. A comprehensive review of industrial progress in the Chinese Empire along many lines. Ills. Serial. 1st part. 9000 w. Tech u Wirt—Feb., 1910. No. 12621 D.

Cost Systems.

See Drafting Rooms, under MECHANICAL ENGINEERING, Machine Elements and Design.

Education.

Impressions of a Visit to Berlin and Its Educational Establishments. Sir George Greenhill. Remarks on the Technische

Hochschule of Charlottenburg and the Militärtechnische Akademie. 2000 w. Engr, Lond—Feb. 25, 1910. No. 12192 A.

Engineering Education in the Navy. From the annual report of H. I. Cone, engineer-in-chief, U. S. Navy. Information concerning the training given. 1200 w. Int Marine Engng—March, 1910. No. 12150 C.

Naval Schools in England (Scuole navali Inglesi). F. Grixoni. An examination and criticism of naval education in England. 7000 w. Riv. Marit—Feb., 1910. No. 12445 E. + F.

See also Laboratories, under ELECTRICAL ENGINEERING, MEASUREMENT.

Government Control.

An Analysis of the Natural Relations between the State and the Industrial Corporations. M. L. Byers. An interesting study of this economic problem. 8500 w. Pro St Louis Ry Club—Feb. 11, 1910. No. 12319.

Labor.

Cost of Living of the Working Classes in Belgium. Review of the fourth report of the Board of Trade. 3000 w. Ir & Coal Trade Rev—March 11, 1910. No. 12506 A.

Industrial Peace (La Paix dans l'Industrie). Sylvain Périssé. Suggests a profit-sharing scheme as the solution of the difficulties between capital and labor. 3500 w. All Indus—Feb., 1910. No. 12435 D.

Labor Insurance.

Employees' Benefit Systems. Gives methods in use by the Carnegie Steel Company, the Western Electric Company and the American Shipbuilding Company. 2500 w. Ir Age—March 31, 1910. No. 12783.

Management.

Organization by Production Factors. A. Hamilton Church. Seventh and concluding article of a series, discussing costs in relation to the financial books. 4500 w. Engineering Magazine—April, 1910. No. 12687 B.

Effect of Reorganization in the Canadian Rifle Factory. Frederick A. Waldron. Gives statements of payroll and output before and after reorganization. Ills. 1000 w. Am Mach—Vol. 33, No. 12. No. 12634.

Natural Resources.

The Waste of Natural Resources in the United States and Future Sources of Power (Die Vergeudung der natürlichen Hilfsquellen in den Vereinigten Staaten Nordamerikas und die Zukünftigen Quellen der Kraft). Walter Giesen. A German view. Ills. Serial. 1st part. 4500 w. Tech u Wirt—Feb., 1910. No. 12622 D.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. Discusses the determination and administration of the task and bonus, showing what has been accomplished. Third part of a serial. 3000 w. Engineering Magazine—April, 1910. No. 12682 B.

The Premium System for the Payment of Wages. H. F. Searle. Describes and discusses some of the best-known methods, showing the advantages or disadvantages of each. 3000 w. Jour of Acc—March, 1910 No. 12299 C.

Replacing Piece by Premium Plan of Paying for Work. L. Chamberlain. Explains the fundamental principle of premium work, and explains how the change can be accomplished. 3500 w. Am Mach—Vol. 33, No. 13. No. 12772.

Piecework. Explains this method of compensating workmen, and the training that should be given to enable the average workman to perform the task. 1500 w. Ry Age Gaz—March 4, 1910. No. 12127.

Relative Efficiency of the Day-Labor and Contract Systems of Doing Municipal Work. Harrison P. Eddy. Examines the advantages and disadvantages of the day-labor system, and the contract system, as applied to municipal work, giving statistics of interest and showing the cost to be less for contract work. General discussion. 14500 w. Jour Assn of Engng Socs—Jan., 1910. No. 12571 C.

MARINE AND NAVAL ENGINEERING.

Barges.

A Self-Dumping Barge. Illustrated description of a self-dumping barge for use at Stockholm. 1200 w. Engng—Feb. 18, 1910. No. 12061 A.

See also Motor Boats, under MARINE AND NAVAL ENGINEERING.

Battleships.

The Battleship of the Future. R. H. S. Bacon. Read before the Inst. of Nav. Archts. Reviews the chief features of battleship design and the trend, owing to progress in modern naval conditions. 4000 w. Engng—March 18, 1910. No. 12736 A.

U. S. S. South Carolina. H. C. Dinger. Description and report of official trials. Plate. 8000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12700 H.

U. S. Battleship North Dakota. Charles B. Edwards. Illustrated description and report of trials. 9000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12699 H.

The "Utah"—Our Latest Dreadnought. Illustration, with brief description of the vessel and its equipment. 1000 w. Sci Am—March 5, 1910. No. 12070.

H. M. Battleship "Vanguard." Brief illustrated description. 700 w. Engng—Feb. 18, 1910. No. 12062 A.

The Brazilian Battleship "Minas Geraes." Photographs and particulars of this latest Dreadnought. 1200 w. Sci Am —March 19, 1910. No. 12349.

The Brazilian Warship "Minas Geraes" (Le Cuirassé Brésilien "Minas Geraes"). E. Lignorelles. Brief description, with report of the official trials. Ills. 2500 w. Génie Civil—Feb. 19, 1910. No. 12441 D.

Destroyers.

Description and Trials of Torpedo-Boat Destroyers Flusser and Reid. William Nelson Little. Ills. 11000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12695 H.

Education.

See same title, under INDUSTRIAL ECONOMY.

Evaporation.

Evaporating Plants on Board Ship. William J. Auken. Describes methods used for increasing the water supply. 2000 w. Int Marine Engng—March, 1910. No. 12151 C.

Fireboats.

The Seattle Fireboat Duwamish. H. Cole Estep. Drawings and description. 2500 w. Marine Rev—March, 1910. No. 12265.

Model Basins.

Experimental Tank at the National Physical Laboratory. Illustrated description of this concrete tank at Teddington and its construction. 1000 w. Engr, Lond —March 11, 1910. No. 12502 A.

The National Experimental Tank. R. T. Glazebrook. Read before the Inst. of Nav. Archts. Report on the progress of the national experimental tank at Teddington. Ills. 1500 w. Engng—March 18, 1910. No. 12733 A.

Motor Boats.

The Largest Commercial Gas Power Boats in the United States. Brief illustrated descriptions of the barges "Contra Costa" and "Benicia." 1800 w. Marine Rev—March, 1910. No. 12266.

See also Aeronautics, under MECHANICAL ENGINEERING, Miscellany.

Naval Architecture.

An Account of the Society for the Improvement of Naval Architecture. A. W. Johns. Read before the Inst. of Nav. Archts. An account of an institution founded nearly 120 years ago. 5500 w. Engng—March 18, 1910. No. 12737 A.

Navy Yards.

The Development of the Norfolk Navy Yard. A. C. Cunningham. Historical review, with plans. 5000 w. Pro U S Nav Inst—March, 1910. No. 12539 F.

Progress.

Improvements in Naval Engineering—Present Development and Future Possibilities. H. C. Dinger. How to increase the efficiency is discussed from the military viewpoint. 14500 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12696 H.

Propellants.

A Sketch of the History of Propellants. Sir Andrew Noble. Information relating to old gun-powders, comparing them with modern propellants. Short discussion. 4500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12548 N.

Propellers.

Geometry of the Turbine-Driven Propeller Dr. John Morrow. An investigation giving in tabular form the relations between developed and projected areas of a wide-bladed screw. 1200 w. Engng—March 11, 1910. No. 12399 A.

Rudders.

Experimental Determination of the Center of Pressure and the Resistance of Rudder Plates (Die Experimentelle Bestimmung des Druckmittelpunktes und Formwiderstandes von Ruderflächen). Dr. William Scholz. Describes the method. Ills. 1700 w. Schiffbau—Feb. 23, 1910. No. 12472 D.

Shipbuilding.

Sixty Years of Merchant Shipbuilding on the North-East Coast. Dr. G. B. Hunter and E. W. De Rusett. Reviews the history of the use of iron as the chief material in ship construction. 7000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12550 N.

See also Navy Yards, under MARINE AND NAVAL ENGINEERING.

Ship Design.

Wasted Horsepower and Economical Trim. William Russell White. A discussion of the needed experiments for the improvement of ship design and ship power. Ills. 5000 w. Pro U S Nav Inst—March, 1910. No. 12538 F.

Ship Stability.

The Stability of Ships. Discusses the conditions that produce a state of balance, and the problems of ship designing. Also the effect of loading. 2000 w. Engr, Lond —March 18, 1910. No. 12740 A.

Steam Auxiliaries.

Marine Auxiliaries. Sidney F. Walker. Considers condensers, evaporators, air-pump for condensers, circulating pumps, feed-water heaters, filters and grease extractors, etc. Ills. 4500 w. Int Marine Engng—March, 1910. No. 12153 C.

Steamboats.

The Stern-Wheel Steamer "Etobe" for Northern Nigeria. Illustrated detailed description of recently built vessels. 700 w. Engng—March 4, 1910. No. 12290 A.

Steam Boilers.

Boiler Attachments and Funnel Draft. H. K. Spencer. Discusses the size of safety valves, stop valves, water columns, fuel pipes, funnels, etc. 3300 w. Inst Marine Engng—March, 1910. No. 12152 C.

See also Boiler Covering, under MECHANICAL ENGINEERING, Steam Engineering.

Steamships.

The Performance of the Turbine Steamers "Mauretania" and "Lusitania." Abstract of an article in the engineering supplement of the *London Times*, by Sir William White. 1200 w. Eng News—March 24, 1910. No. 12589.

Notes on the Trials and Performance of the S. S. "Otaki," Fitted with a Combination of Reciprocating and Turbine Machinery. W. McK. Wisnom. This was the first merchant vessel fitted with this "combination system" of machinery. Report and discussion. 4 plates. 12500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12549 N.

The Second Turbine Steamer for the Japanese Volunteer Fleet. Illustrated description of the Umegaka Maru, a triple-screw turbine steamer. 2500 w. Inst Marine Engng—March, 1910. No. 12149 C.

A New Type of Ore Carrying Steamship. Illustrated description of the Vollrath Tham, built at the Hebburn Shipyard on the Tyne. 1200 w. Engr, Lond—March 18, 1910. No. 12743 A.

Details of the Russian Volunteer Steamer "Orel." Drawings, illustrations and description of five single-screw steamers and their machinery, intended for the Vladivostock and Shanghai service. Plate. 1200 w. Engng—March 11, 1910. No. 12397 A.

Twin-Screw Freight and Passenger Steamship "Cincinnati" (Doppelschrauben Fracht- und Passagierdampfer "Cincinnati," erbaut von der Schiffswerft F. Schichau, Elbing und Danzig). A. Oesten. Brief illustrated description, with detailed plans. 2200 w. Schiffbau—Feb. 9, 1910. No. 12471 D.

Steam Turbines.

Impulse Marine Turbines in Germany. Illustrates and describes designs and arrangement of machinery in German navy vessels, comparing with British practice. 2000 w. Engr, Lond—March 18, 1910. No. 12739 A.

A New Solution of the Problem of Marine Turbines (Nouvelle Solution du Problème des Turbines marines). M. Föttinger. Brief description of the Föttinger hydraulic transmission gear abstracted from the *Zeitschrift des Vereines Deutscher Ingenieure*. Ills. 1800 w. Rev de Mécan—Feb., 1910. No. 12416 E + F.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

The Latest French Topedo Boat Destroyers. A critical review, with illustrations and report of trials. Plate. 2500 w. Engr, Lond—March 11, 1910. No. 12500 A.

A Boat-Torpedo of Enormous Destructive Power, Carrying Its Own Gasoline Engine and Crew. Illustrations and brief description of a semi-submarine boat-torpedo for the U. S. Navy, soon to be tested. 700 w. Eng News—March 17, 1910. No. 12309.

Tugs.

Twin-Screw Tug Boats for the North-Eastern Railway. Illustrated detailed description of two powerful tug boats recently built. 800 w. Engr, Lond—Feb. 25, 1910. No. 12194 A.

U. S. Merchant Marine.

The Merchant Marine and the Navy. T. G. Roberts. Discusses the ills of the U. S. merchant marine and the weakening effect on the navy. 15000 w. Pro U S Nav Inst—March, 1910. No. 12536 F.

Warships.

Fifty Years of Warship-Building on the Clyde. J. H. Biles. Describes the principal points in connection with the individual ships or classes of ships built on the Clyde during the last fifty years. Ills. 9000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1910. No. 12551 N.

MECHANICAL ENGINEERING.

Austin.

The New 15 Horsepower Austin. Calls attention to improvements in this new model. A larger stroke, four speeds, an interesting system of lubrication. 1200 w. Autocar—March 12, 1910. No. 12384 A.

Brakes.

Brakes and Their Limitations. Investigates the effect of brake action. 1700 w. Autocar—March 12, 1910. No. 12385 A.

Service and Emergency Brakes and Their Operation. Albert L. Clough. Considers the limit of brake power, the fault of hand brakes and exclusive pedal operation. 1000 w. Horseless Age—March 2, 1910. No. 12138.

Clutches.

Tendencies in Clutch Design. M. R. Wells. A comparison of types as shown at the recent exhibitions, discussing the cause of the changes. 1500 w. Horseless Age—March 9, 1910. No. 12232.

Clutch Repairs and Maintenance. Oliver Light. Analyzes some of the successful forms showing their weaknesses and suggesting methods of repairing them. Ills. 3500 w. Automobile—Feb. 24, 1910. No. 12043.

Control.

Pedals and Hand Levers. Illustrates and describes recent types. 1500 w. Horseless Age—Feb. 23, 1910. No. 12044.

Delaunay-Belleville.

The Delauany-Belleville Four-Cylinder "Ten." Illustrated description. 800 w. Auto Jour—Feb. 19, 1910. No. 12049 A.

Electrical Instruments.

Electrical Instruments for the Automobile. Joseph B. Baker. Illustrates and describes types of electrical indicating instruments for testing and maintaining the equipment of the car. 2000 w. Horseless Age—March 2, 1910. No. 12139.

Gaeth.

Gaeth Type XXI. Illustrated description of this company's improved 4-cylinder car. 1200 w. Horseless Age—March 23, 1910. No. 12679.

Gasoline Analysis.

Gasoline Analysis—Theoretical Computations of Gasoline Used in Tests. J. M. L. Howe and G. W. Lewis. 1500 w. Horseless Age—March 23, 1910. No. 12675.

Gears.

The Correct Gear-Ratio for a Touring Car. Describes an ingenious graphic method of determination. 1800 w. Autocar—March 19, 1910. No. 12714 A.

A New Type of Differential Gear. Illustrated description of the Graham differential gear in which the power is taken by the wheel offering the greater resistance. 1200 w. Autocar—March 19, 1910. No. 12713 A.

Houpt-Rockwell.

Original Features in Houpt-Rockwell "60." Illustrated description. 1500 w. Horseless Age—March 23, 1910. No. 12678.

Ignition.

Magneto versus Battery Ignition. Albert L. Clough. Presents the advantages and disadvantages of the two systems. 700 w. Horseless Age—March 2, 1910. No. 12136.

Multiple Coils versus the High Tension Distributor. Albert L. Clough. Reviews the advantages and disadvantages of each. 600 w. Horseless Age—March 2, 1910. No. 12137.

Ignition Advance. H. H. Brown. Explains briefly the causes rendering ignition advance necessary, and discusses the effect of compression on rapidity of combustion, and related matters. 2500 w. Horseless Age—Feb. 23, 1910. No. 12045.

Some Characteristic Features of High and High-Low Tension Magnetos. Albert L. Clough. Discusses these two types. 1800 w. Horseless Age—March 9, 1910. No. 12231.

Probable Future Developments in Ignition Practice. Albert L. Clough. Suggestions, describing a dynamo lighting ignition outfit, and discussing probable changes. 2000 w. Horseless Age—March 16, 1910. No. 12343.

Lorraine-Dietrich.

The Lorraine-Dietrich "Twelve-Sixteen." Illustrated description of this small car of the 75 M.M. class. 900 w. Auto Jour—March 5, 1910. No. 12275 A.

Lubrication.

How Efficient Lubrication Reduces Maintenance. A study of the proper and complete lubrication of automobiles. 2000 w. Automobile—March 17, 1910. Serial. 1st part. No. 12362.

Motors.

The One-Stroke Engine. Illustrated description, showing the functions of the various component members. 1500 w. Autocar—Feb. 19, 1910. No. 12048 A.

Long Stroke versus Short Stroke Motors. Elwood Haynes. Discusses the ratio between bore and stroke. 3000 w. Horseless Age—March 23, 1910. No. 12676.

Some Two-Cycle Phenomena. Dr. Charles W. Snyder. Gives results of experimental work with a two-cycle engine, calling attention to facts of interest to two-cycle designers. Ills. 4000 w. Horseless Age—March 2, 1910. No. 12135.

The Enderby-Johnson Experimental Engine. Brief illustrated description of a double-acting two-stroke model. 1000 w. Auto Jour—Feb. 26, 1910. No. 12175 A.

Shock Absorbers.

Automobile Shock Absorbers (Les Amortisseurs d'Automobiles). E. Girardault. A review of their uses, the different types and examples of each type. Ills. Serial. 1st part. 3500 w. Génie Civil—Feb. 5, 1910. No. 12437 D.

Speedometers.

The Speedometer Question in Switzerland (Die Geschwindigkeitsmesserfrage in der Schweiz). Herr Pflug. An outline of the recent regulations issued by the Swiss Department of the Interior respecting speed indicating devices for automobiles. 3500 w. Zeitschr d Mitt Motorwagen Ver—Feb. 15, 1910. No. 12485 D.

Results of Tests of Speedometers (Ergebnis der Prüfung von Geschwindigkeitsmessern). Herr Pflug. Gives results of tests on twenty-two devices investigated in connection with the recent Swiss regulations. 6500 w. Zeitschr d Mit Motorwagen Ver—Feb. 28, 1910. No. 12486 D.

Steering Gears.

Some Notes on Steering Connections. J. L. Napier. Explains the principles involved in the designing of steering gears. 1400 w. Autocar—Feb. 19, 1910. No. 12047 A.

Talbot.

The 15 h. p. Four-Cylinder Talbot. Illustrated description of detail improvements introduced. 1200 w. Autocar—March 19, 1910. No. 12712 A.

Taximeters.

Taximeters and Public Cab Operation. Harold Brown. Discussion of instruments for the registration of fares and charges, illustrating and describing types in common use. 4000 w. Com Veh—March, 1910. No. 12161 C.

Tires.

Some Common Tire Fallacies Exploded. D. W. Samways. Abstract of paper read before the Roy. Auto Club of Gt. Britain and Ireland. An explanation of the forces acting on the rim and wheel, discussing the advantages of a high tire and a low one, and how to prolong their life. 1700 w. Automobile—March 3, 1910. No. 12093.

Transmission Loads.

Graphical Determination of Transmission Loads. L. C. Freeman. Analysis, with the idea of determining the maximum loads imposed on ball bearings by the action of the gears. 2000 w. Automobile—March 17, 1910. No. 12361.

Transmissions.

Some Transmission Mechanisms in Modern Shaft-Driven Automobiles. Forrest R. Jones. Discusses the location of the transmission, the use of one universal joint as compared with the earlier practice of using a pair, and other features. 2200 w. Automobile—March 3, 1910. No. 12094.

COMBUSTION MOTORS.

Aeronautic Motors.

Motors for Aerial Navigation. J. S. Critchley. Read before the Inc. Inst. of Auto. Engrs. States the requirements, illustrating and describing types of each class. 3500 w. Mech Engr—Feb. 18, 1910. Serial. 1st part. No. 12057 A.

Carburetters.

Carburetters for Internal-Combustion Engines. A carburetter designed and patented by Sir Hiram Maxim is illustrated and described. 2200 w. Prac Engr—March 18, 1910. No. 12723 A.

Gas Engines.

The Gas Engine. Dr. Charles E. Lucke. Abstract of the fifth Hewitt lecture, delivered at Cooper Union. 1500 w. Power—March 15, 1910. No. 12269.

Constructive Details of Double-Acting Four-Stroke Cycle Gas Engines (Konstruktive Einzelheiten an doppeltwirkenden Viertaktgasmaschinen). R. Drawe. A discussion of cylinder, piston and valve construction. Ills. Serial. 1st part. 4000 w. Stahl u Eisen—Feb. 9, 1910. No. 12458 D.

See also Blowing Engines, under MINING AND METALLURGY, Iron and Steel.

Gasoline Engines.

A Novel Hydrocarbon Engine. Diagrams and description of a 50-h.p., 4-cylinder motor with variable piston stroke. The invention of Messrs. Gill and Aveling. 900 w. Sci Am Sup—March 26, 1910. No. 12646.

See also Aeronautics, under Miscellany.

Gas Producers.

Fuels for Gas Engines. Dr. Charles E. Lucke. Part of the sixth Hewitt lecture delivered at Cooper Union. Discusses the gasification of coal for gas-engine purposes. Ills. 1500 w. Power—March 22, 1910. Serial. 1st part. No. 12512.

Gas Turbines.

The Gas Turbine. A. W. H. Griepe. Considers the Stolze proposed turbine, the Wegner turbine, and the author's design. Ills. 1000 w. Power—March 8, 1910. No. 12172.

Ignition.

Electrical Ignition in Combustion Motors (Allumage électrique des Moteurs à Explosion). A. Bainville. A review of the systems of producing the current and of sparking devices. Ills. 3000 w. L'Elecn—Feb. 12, 1910. No. 12428 D.

Oil Engines.

Weights of Moving Parts in Oil Engines. Frederick Strickland. Considers that pistons, connecting rods, etc., are often made too heavy. 1500 w. Horseless Age—March 23, 1910. No. 12677.

The Extension of the Use of the Diesel Motor (Der Dieselmotor und seine Verbreitung). Brief notes on installations of Sulzer and Augsburg-Nürnberg Diesel motors for driving electric generators. Ills. 2200 w. Elek Kraft u Bahnen—Feb. 24, 1910. No. 12603 D.

See also Centrifugal Pumps, under Hydraulic Machinery.

Producer Gas.

An Ambitious Scheme of Heat Utilization. Illustrates and outlines a plant developed by Dr. J. M. W. Kitchen of East Orange, N. J., aiming to utilize all heat carried by heated air or heated water. 3500 w. Met Work—March 5, 1910. No. 12131.

Economizing the Waste Heat in Power Generation. J. M. W. Kitchen. States the more important principles to be applied in saving heat in power generation, giving diagram and explanation of the author's composite system. 1500 w. Power—March 29, 1910. No. 12747.

HEATING AND COOLING.

Air Purification.

See Ozone, under ELECTRICAL ENGINEERING, Electro-Chemistry.

Central Plants.

See Central Stations, under ELECTRICAL ENGINEERING, Generating Stations.

Hot-Air Heating.

Opportunities in the Field of Warm Air. James D. Hoffman. Discusses defects in furnaces and furnace heating installations, suggesting remedies. 2000 w. Met Work—March 19, 1910. No. 12360.

Furnace Heating of an Eight-Room School. Illustrates and describes an arrangement including an exhaust fan driven by a water motor. 2200 w. Met Work—March 12, 1910. No. 12252.

Liquid Air.

Industrial Applications of Extremely Low Temperatures (Quelques Applications industrielles des très basses Températures). A. Lancien. A review of the uses of liquid air and other liquified gases. 2400 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12409 D.

Refrigeration.

Refrigeration for Cold Storage. Nelson Waite. Discusses the comparative value of direct and indirect refrigeration for cold storage plants. 2000 w. Ice & Refrig—March, 1910. No. 12165 C.

A Two-Hundred Ton Ice-Making Plant. Illustrated description of a large plant at Grimsby, Eng., on the ammonia-compression system. Plate. 800 w. Engr, Lond—Feb. 18, 1910. No. 12065 A.

The Brewing Exposition in Munich, 1909 (Von der Brauereiausstellung in München 1909). C. Guillery. Describes the exhibits in the refrigeration section. Ills. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1910. No. 12608 D.

See also Calorimetry, under Measurement; and Refrigeration, under RAILWAY ENGINEERING, Motive Power and Equipment.

School Buildings.

Heating and Ventilating Minnesota Schools. Illustrates and describes practice in accord with the regulations of the Minnesota State Board of Health. 1200 w. Met Work—Feb. 26, 1910. No. 12042.

Steam Heating.

Steam Heating Systems in Common Use. J. P. Lisk. Discusses their adaptability and gives tables showing the size of pipe to supply a given amount of radiation. 2000 w. Power—March 15, 1910. No. 12268.

Successful Heating of Our Homes. A. G. King. This number discusses the principal points which make a heating boiler effective. 1800 w. Archts & Bldrs' Mag—Feb., 1910. Serial. 1st part. No. 12211 C.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Franz zur Nedden. This fourth part of a series considers the turbo-pump diagram and its practical interpretation in service. 3500 w. Engineering Magazine—April, 1910. No. 12685 B.

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York. Discussion at St. Louis of the paper by Prof. R. C. Carpenter. 4000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12353 F.

Centrifugal Pumps Operated by Diesel Motors (Wasserwerke mit Kreiselpumpen und Dieselmotorenbetrieb). Discusses the technical and economic success of plants of this type, illustrating a number of installations. 2300 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12402 D.

Presses.

See Cylinders, under Machine Elements and Design.

Pumping Plants.

Steam-Driven Pumping Plant for Deep Wells and Bore-Holes. Alfred Towler. Read before the Assn. of Water Engrs. Indicates the principles which affect the durability and efficiency of rod-pumps, and describes the plant at Stocks Well Pumping Station. Ills. 6400 w. Engng—Feb. 25, 1910. No. 12190 A.

Tests and Notes on Method of Operation of a Producer Gas Pumping Plant. James R. Fitzpatrick. Illustrated account of the plant of the Grand Rapids Hydraulic Company. Discussion. 5500 w. Pro Am W-Wks Assn—1909—No. 12761 N.

See also Dams, and Water Works, under CIVIL ENGINEERING, Water Supply.

Pumps.

Roberts Direct-Acting Hydraulic Pump. Illustrates and describes a combination of a piston-pump, a piston and plunger pump, and a ram pump. 1000 w. Engng—March 11, 1910. No. 12395 A.

Suction Height of Piston Pumps (Saughöhe und Ansaugen der Kolbenpumpen). F. Schönberger. A discussion of results obtained in practice. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12618 D.

Turbine Governors.

A New High-Pressure Turbine Governor (Eine neue Hochdruckturbinenregulierung). Andreas Stamm. Illustrated description of a regulating device applied to a 5,500 horse-power Pelton wheel. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12401 D.

Turbines.

Design and Construction of Four 9000 H. P. Turbines. H. Birchard Taylor. Illustrated description of hydraulic turbines installed in the Little Falls plant on the Spokane River, Washington. 2200 w. Am Mach—Vol. 33. No. 12. No. 12638.

Standard Coefficients of Modern High-Pressure Francis Turbines (Massgebende Koeffizienten von modernen Hochdruck-Francisturbinen). Mario Dornig. Mathematical discussion of the coefficients and the relations between them. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12403 D.

Turbine Tests.

Acceptance Tests of the Turbines and Regulators for the Gullspang Power Plant, Sweden (Abnahmeversuche an den Turbinen und Regulatoren des Wasserkraftwerkes Gullspang, Schweden). H. Th. Holm. Describes and gives results of tests on the 4,000 horse-power double Francis turbines. Ills. Serial. 1st part. 800 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 28, 1910. No. 12400 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Why Have Ball Bearings Been a Failure? E. J. Baechle. Discusses the results of Prof. Stribeck's investigations and researches in the rolling and sliding action of balls. Ills. 1500 w. Am Mach—Vol. 33. No. 12. No. 12636.

Cylinders.

Design of Hydraulic Press Cylinders. A. Lewis Jenkins. Suggestions, with formulae for thick cylinders. 1500 w. Am Mach—Vol. 33. No. 13. No. 12771.

Drafting Rooms.

An English Drafting Room and Efficient Cost System. I. William Chubb. Especially describes the division of work and fixing responsibility. 3000 w. Am Mach—Vol. 33. No. 9. No. 12120.

Gears.

Solution of Epicyclic Gearing by the Method of Levers. John S. Myers. Gives problems illustrating the method known as separate motions, and applying the lever method. Ills. 2000 w. Mach, N Y—March, 1910. No. 12072 C.

The Calculation of Spur-Gear Teeth (Sur le Calcul des Dents d'Engrenages droits). R. André. Mathematical demonstration of method. Ills. 3000 w. All Indus—Feb., 1910. No. 12434 D.

Gyroscopes.

How a Gyroscope Acts. C. E. Wolff. Explains the nature of the action and how to calculate the turning moment corresponding to any rotation of the axis. 1000 w. Mech Engr—Feb. 25, 1910. No. 12184 A.

Mechanics of the Gyroscope. Irving P. Church. A study of its properties. Mathematical. 3500 w. Cornell Civ Engr—March, 1910. No. 12544 C.

Shrinkage Stresses.

Shrinkage and Forced Fits and the Stresses They Produce. A. Lewis Jenkins. An investigation of such stresses, with allowances such as are commonly used in practice, illustrating by examples. 2500 w. Eng News—March 17, 1910. No. 12308.

Springs.

Slide Rule for Helical Spring Calculations. M. E. Davis. Gives a reproduction of the graduations on a slide rule used for such calculations, with directions for its use. 800 w. Mach, N Y—March, 1910. No. 12073 C.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

See Electric Driving, under POWER AND TRANSMISSION.

Brass Founding.

Casting Long Liners. Walter J. May. Suggestions helpful in casting long, thin articles in copper alloys. 600 w. Prac Engr—March 11, 1910. No. 12387 A.

Bronze Founding.

The Gating and Pouring of Manganese-Bronze. W. R. Dean. An illustrated article giving suggestions for successful work. 1500 w. Brass Wld—March, 1910. No. 12540.

Castings.

Segregation Phenomena in Steel Castings. S. S. Knight. Read at meeting of the Phila. Found. Assn. An illustrated account of results of recent metallographic investigations. 3000 w. Ir Age—March 3, 1910. No. 12058.

Cupola Practice.

Theoretical Notes on Cupola Reactions (Theoretische Betrachtungen über die Vorgänge im Kupolofen). H. Holm. Discusses the heat balance of the cupola. Ills. 2700 w. Stahl u Eisen—Feb. 2, 1910. No. 12454 D.

Drilling Machines.

Radial Drilling Machines Break Drills and Records. F. E. Bocorselski. Illustrated account of drilling tests made by the American Locomotive Co. 1500 w. Am Mach—Vol. 33. No. 11. No. 12334.

Foundry Practice.

Steel Foundry Practice. Percy Longmuir. Read before the Manchester Assn. of Engrs. A survey of steel foundry practice, the processes followed, and the difficulties met. 3000 w. Mech Engr—March 4, 1910. No. 12285 A.

Foundry Ventilation.

The Removal of Dust in Iron Works and Foundries (Die Staubbeseitigung in Hüttenwerken und Giessereien). Ernst A. Schott. Illustrated detailed description of dust-removal systems and devices applicable to individual machines. Serial. 1st part. 4000 w. Stahl u Eisen—Feb. 2, 1910. No. 12453 D.

Gear Cutting.

Self Generating Spur Gear Machine of English Design. I. W. Chubb. Illustrated description of the Sunderland gear generator. 2000 w. Am Mach—Vol. 33. No. 10. No. 12236.

A Simple Jig for Cutting Worm-Wheel Teeth. Illustrates and describes a device for cutting standard worm wheels. 2500 w. Prac Engr—March 18, 1910. No. 12722 A.

Lathes.

12-Inch High-Speed Lathe. Illustrates and describes a new high-speed lathe with all-gear single-pulley head. 500 w. Engr, Lond—March 4, 1910. No. 12295 A.

Recent High-Speed Lathes (Neue Schnelldrehbänke). Fr. W. Hülle. Detailed descriptions of two new German lathes. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12615 D.

Machine Tools.

Special Machines for Making Large Spherical Bearings. Robert Reid. Illustrates and describes types. 1000 w. Am Mach—Vol. 33. No. 12. No. 12637.

Metal Spinning.

Metal Spinning. William A. Painter. Illustrates and describes in detail the various operations of spinning metal. 4000 w. Mach, N Y—March, 1910. No. 12071 C.

Molding.

Match-Plates for Stove Castings. Illustrates and describes the method of molding stove plate by the use of hinged match-plates and flasks. 6000 w. Foundry—March, 1910. No. 12091.

Molding Machines.

Machine Molding of Cast Tubes (Maschinelle Herstellung von Formen für stehend zu giessende Rohre). R. Ardelt. Describes a number of machines and processes. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Feb. 2, 1910. No. 12452 D.

Pipe Founding.

See Molding Machines, under Machine Works and Foundries.

Planing Machines.

Direct Electric Drive for Planing Machines (Direkter elektrischer Antrieb von Hobelmaschinen). Describes the system of the Felten & Guilleaume-Lahmeyerwerke. Ills. 2200 w. Zeitschr f Werkzeug—Feb. 5, 1910. No. 12492 D.

Presses.

Testing Power Presses to Find Capacity and Rating. H. Gansslen. Gives suggestions for researches in selecting a press for doing certain work. Ills. 2800 w. Am Mach—Vol. 33. No. 10. No. 12237.

Shop Appliances.

Making a Precision Dividing Wheel. Illustrated description of a wheel made by grinding a series of disks and clamping them around a rim of such diameter that the disks all touch each other and the rim simultaneously. 1500 w. Mach, N Y—March, 1910. No. 12076 C.

Turret Lathe Equipment for Making Automobile Parts. C. L. Goodrich. Illustrates and describes a number of recent adaptations for producing rapid work. 1000 w. Am Mach—Vol. 33. No. 10. No. 12235.

Milling Fixtures for Automobile Parts. E. H. Pratt. Illustrates and describes special fixtures for producing accurate work. 1000 w. Mach, N Y—March, 1910. No. 12080 C.

Shop Floors.

See Concrete, under CIVIL ENGINEERING, Materials of Construction.

Shop Practice.

Some Notes on Shop Economics. C. E. Coolidge. Brief illustrated discussion of machine shop equipment. 2000 w. Sib Jour of Engng—March, 1910. No. 12554 C.

Machine Shop Practice. The present number deals with tool grinding. Plate. 1200 w. Mach, N Y—March, 1910. No. 12079 C.

Modern Automobile Building Methods in a French Shop. Illustrates and describes machines used in making the Berliet car in Lyons, France. 1200 w. Am Mach—Vol. 33. No. 9. No. 12118.

Methods of Handling Automatic Turret Work. F. A. Stanley. Illustrates and describes ways and means of handling various pieces upon chuck or face plates. 2500 w. Am Mach—Vol. 33. No. 9. No. 12119.

Methods of Holding and Machining Lathe Work. F. A. Stanley. Illustrates and describes interesting adaptations of the turret machine with automatic chuck. 1200 w. Am Mach—Vol. 33. No. 13. No. 12770.

The Machining of Large Work by Unusual Methods. Illustrates and describes special tools and devices used on large gas engines. 2000 w. Am Mach—Vol. 33. No. 9. No. 12121.

Lathe Building Operations in Well Equipped Shop. F. A. Stanley. Half tones, engravings and descriptions of tools employed in machining and testing parts in a Cincinnati shop. 2200 w. Am Mach—Vol. 33. No. 11. No. 12335.

Shop Kinks. Gives the nineteenth to twenty-fifth collections inclusive, with also a collection of miscellaneous kinks. Ills. 5000 w. Ry Age Gaz—March 4, 1910. No. 12130.

See also Shops, under RAILWAY ENGINEERING, Motive Power and Equipment.

Shops.

Shrinking and Tempering Shop for Guns at Woolwich Arsenal. A short account of previous methods and appliances for dealing with this problem, and illustrated detailed description of this new shop. Plate. 4000 w. Engng—Feb. 25, 1910. No. 12188 A.

The Works of Messrs. Ackroyd and

Best, Limited, Morley, Leeds. Illustrated description of these works and of the manufacture of Hailwood's safety lamp and underground relighter. 3500 w. Col Guard March 18, 1910. No. 12729 A.

Shop Ventilation.

The Removal of Fumes in Factories (Elimination des Buées industrielles). Paul Razous. Discusses the formation of fumes in various industries, their hygienic effects, and methods of removing them. Serial. 1st part. 3500 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12407 D.

Tempering.

See Shops, under MACHINE WORKS AND FOUNDRIES.

Tin-Box Making.

A Tin Box Factory at Barking. Illustrates and describes methods used at this factory, with plan of the works. 1200 w. Engr, Lond—March 4, 1910. No. 12294 A.

Tool Making.

A Central Tool Dressing Plant in a Navy Yard. W. H. Taylor. Illustrated description of a plant supplying tools for several yards on the Atlantic coast. 2500 w. Am Mach—Vol. 33. No. 10. Serial. 1st part. No. 12233.

Tools.

Circular Form and Cut-Off Tools. Douglas T. Hamilton. Illustrates and describes the practice for the Brown & Sharpe screw machines. 3000 w. Mach, N Y—March, 1910. No. 12075 C.

Welding.

Electric and Autogenous Welding. Editorial review of what has been accomplished, showing the value of these methods. 3000 w. Engng—March 4, 1910. No. 12291 A.

Autogenous Welding. Fred W. Wolf, Jr. Discusses the processes and the applications to cooling apparatus. 3300 w. Ice & Refrig—March, 1910. No. 12166 C.

Oxy-Acetylene Welding. H. S. Smith. Describes the plants employed in the high and low pressure systems and their fields of operation, and the classes of work on which the system can be advantageously employed. General discussion. 8000 w. Jour Soc of Arts—Feb. 25, 1910. No. 12174 A.

Electric Welding of Copper, Brass and Aluminum. A. E. Buchenberg. Explains some of the difficulties and describes the electric method, giving cost. 1800 w. Mach, N Y—March, 1910. No. 12077 C.

A Striking Oxy-Carbi Boiler Fusion Weld. Frank C. Perkins. Illustrates and describes the welding of a patch in the flue sheet of the fire-box. 1000 w. Boiler Maker—March, 1910. No. 12227.

Electrolytic Production of Hydrogen and Oxygen for Autogenous Welding (Die Selbstherstellung von Wasserstoff und Sauerstoff durch Elektrolyseure für autogene Schweissung). Herr Hopfer discusses the commercial production of these gases, the equipment, cost, etc. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12612 D.

An Experimental Study of the Strength of Welds (Étude experimentale de la Resistance des Soudures). Ch. Fremont. Reports results of tests on welds made by various processes. Ills. 6500 w. Génie Civil—Feb. 26, 1910. No. 12443 D.

Wood-Working Machinery.

Safety Appliances for Planers (Appareils de Protection pour les Dégauchisseuses). Henri Mamy. Describes a number of protective devices. Ills. 2000 w. Génie Civil—Feb. 19, 1910. No. 12442 D.

MATERIALS OF CONSTRUCTION.

Alloys.

A Study of Metallic Alloys (Etude sur les Alliages Métalliques). J. Chaussin. A general review of the structure of alloys, effects of working and heat treatment, etc. 4200 w. Rev d'Econ Indus—Feb. 20, 1910. No. 12408 D.

Alloy Steels.

Trend of Steel Specifications to Meet Present Requirements. C. A. Tupper. A review of the various steel alloys and their capacities. 7000 w . Am Mach—Vol. 33, No. 12. No. 12635.

The Various Effects of Manganese in Steel. E. F. Lake. A review of the properties and effects of this element. 1500 w. Am Mach—Vol. 33, No. 10. No. 12238.

Aluminium.

The Analysis of Aluminium and Its Alloys. Richard Seligman and F. J. Willott. Describes rapid analytical methods used in the industrial laboratory. 4000 w. Mech Engr—March 11, 1910. No. 12389 A.

Bronzes.

The Elastic Limit of Manganese and Other Bronzes. J. A. Capp. A report of tests showing that the value commonly obtained from rapid commercial tests on bronze may be quite misleading. 2500 w. Jour Am Soc of Mech Engrs—March., 1910. No. 12352 F.

Cast Iron.

A Comparison of Specifications for Cast Iron in Germany and the United States (Vergleichende Zusammenstellung der Lieferbedingungen für Gusseisen in Deutschland und den Vereinigten Staaten). Presents the specifications in parallel tables. Ills. 2000 w. Stahl u Eisen—Feb. 2, 1910. No. 12455 D.

See also Test Bars, under MEASUREMENT.

Metallography.

The Properties of Metals and Metallic Compounds (Die Eigenheiten von Metallen und Metallverbindungen). G. Goldberg. A brief review of metallographic principles. Serial. 1st part. 1500 w. Giesserei-Zeit—Feb. 15, 1910. No. 12464 D.

The Theoretical Form of the Cooling Curves of Binary Alloys (Sur la Forme Théorique des Courbes de Refroidissement des Mélanges binaires). E. Rengade. A general discussion of the characteristics exhibited by cooling curves. Ills. 3600 w. Rev de Métal—Feb., 1910. No. 12413 E + F.

The Importance of Metallography in the Iron Industry (Die Bedeutung der Metallographie für die Eisenindustrie). P. Oberhoffer. A discussion of its field of usefulness and a review of the metallography of iron and steel. Ills. 4000 w. Stahl u Eisen—Feb. 9, 1910. No. 12457 D.

The Influence of Manganese Sulphide on Iron and Steel. Donald M. Levy. Read before the Staffordshire Iron & Steel Inst. Gives results of scientific investigations. Ills. 6000 w. Ir Trad Rev —March 3, 1910. No. 12112.

Refractory Materials.

See Boiler Furnaces, under STEAM ENGINEERING.

Steel.

The Hardness of Quenched Steels, with Particular Reference to Quenched Case Hardened Steels. Messrs. Portevin and Berjot, in *Revue de Metallurgie*. Gives an account of researches and conclusions. 800 w. Ir Age—March 31, 1910. No. 12782.

Observations on Segregation Phenomena as Applied to Cast Steels. S. S. Knight. Read before the Phila. Found. Assn. Discusses the value of microscopy and synthetic chemistry in metallographic investigation. Ills. 2000 w. Ir Trd Rev —March 10, 1910. No. 12224.

MEASUREMENT.

Calorimetry.

Specific Heat of Some Calcium Chloride Solutions Between — 35° C. and + 20° C. H. C. Dickinson, E. F. Muller, and E. B. George. An investigation of the values of specific heat at temperatures employed in refrigeration practice, comparing two methods. Ills. 6500 w. Bul Bureau of Stand—Feb., 1910. No. 12563 N.

Experimental Determination and Registration of the Calorific Power of Gases (Détérmination expérimentale et Enregistrement du Pouvoir calorifique des Gaz). E. Lemaire. Description of the construction and use of the Junkers calorimeter. Ills. 2500 w. Génie Civil—Feb. 12, 1910. No. 12440 D.

Dynamometers.

An Improved Absorption Dynamometer. C. M. Garland. Illustrates and describes a magnetic absorption dynamometer and its operation. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12350 F.

Some Recent Dynamometers (Quelques Dynamomètres récents). An illustrated review of dynamometers invented during the last eight years. Serial. 1st part. 4000 w. Rev de Mécan—Feb., 1910. No. 12423 E + F.

Gauges.

Proposed Decimal Limit Gauge for Wire, Sheet Metal, and Tubing. George E. Goddard. Explains the need of concerted attention to the subject of these gauges, and gives a table of the proposed gauge. 2500 w. Horseless Age—March 23, 1910. No. 12674.

Thread Gages for Bolt-Work on French Railways. Charles B. King. Illustrates and describes the system employed by the State Railways of France. 700 w. Mach, Ry Ed—Feb., 1910. No. 12273 C.

Impact Tests.

Comparative Static and Dynamic Bending Tests on Notched Bars (Essais comparatifs de Flexion statique et dynamique sur Barreaux entaillés). A. Léon and P. Ludwik. Translated from *Oesterreichische Wochenschrift für den öffentlichen Baudienst* for Feb. 13, 1909. Ills. 2300 w. Rev de Métal—Feb., 1910. No. 12415 E + F.

Pressure.

Testing Pressures with Lead Cylinders. W. T. Sears. Gives curves and records of compression tests, and remarks. 1500 w. Am Mach—Vol. 33. No. 10. No. 12234.

Steam Meters.

The Pitot Tube as a Steam Meter. Discussion of paper by George F. Gebhardt. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12358 F.

Tests with Recording Steam Meters (Versuche mit selbstaufzeichnenden Dampfmessern). K. Rummel. A discussion of the theory of their design, and detailed results of an extended investigation. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12610 D.

Test Bars.

A Report on Cast Iron Test Bars. Discussion of A. F. Nagle's paper. 1200 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12356 F.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. A study of the application of various formulæ to practical work. 800 w. Prac Engr—March 4, 1910. No. 12283 A.

Air Compressor Testing. E. A. Fessenden. Discusses the displacement method and the orifice method for determining the capacity. Also a modified orifice method and the Venturi meter method. Ills. 3000 w. Mach, N Y—March, 1910. No. 12074 C.

Compressed Air.

Compressed Air and Its Uses. Discusses the industrial value of compressed air, illustrating and describing types of compressors, and applications. 5000 w. Ir Age—March 3, 1910. Serial. 1st part. No. 12052.

Pneumatic Hose Fittings. Illustrates and describes the "Titan" fittings, designed to lessen accidental losses and prevent improper use. 1200 w. Engr, Lond—Feb. 18, 1910. No. 12066 A.

Electric Driving.

The Operation and Care of Small Electrical Machinery. Henry B. Bixler. Practical suggestions for making repairs, locating troubles, and removing the causes. Plate. 2500 w. Mach, N Y—March, 1910. No. 12078 C.

Location and Care of Motors in Industrial Plants. William Kavanagh. Suggestions for the arrangement and mounting of motors. 1200 w. Elec Wld—March 3, 1910. No. 12106.

The Powering of Boiler Shops. D. S. Downs. Discusses the three classes of electrical systems which fulfill the power requirements of the boiler shop. Ills. 1600 w. Boiler Maker—March, 1910. No. 12229.

Two-Motor Drive for Web Printing Press. S. H. Sharpsteen. Discusses how standard motors and control devices may be applied to the electrical operation of printing presses. 1500 w. Elec Wld—March 3, 1910. No. 12105.

Electricity in a Modern Laundry. Illustrated description of an installation in San Francisco. 1500 w. Elec Rev, N Y—March 19, 1910. No. 12363.

Ring Spinning Frames (Le Métier continu à Filer). An exhaustive discussion of the application of electric power to ring spinning frames prepared by Brown, Boveri & Co. Ills. 5000 w. All Indus—Feb., 1910. No. 12433 D.

See also Planing Machines, under Machine Works and Foundries.

Lubricants.

See Fuel Purchasing, under Steam Engineering.

Mechanical Plants.

Heating and Ventilating the Morgan Memorial Building, Hartford, Conn. Putnam A. Bates. Brief illustrated description of this beautiful art-building, with detailed description of the mechanical arrangements for heating and ventilation. 4000 w. Eng Rec—March 26, 1910. No. 12666.

Power Generation.

Steam Boilers and Combustion. Charles Edward Lucke. Third Hewitt lecture at Cooper Union hall. Explains the principles upon which boilers are constructed and outlines the essentials of combustion. 2500 w. Power—March 1, 1910. No. 12041.

Economy in Generating Steam Power. Charles Edward Lucke. Fourth Hewitt lecture in Cooper Union hall. Considers the saving effected by the use of apparatus to reclaim waste heat, and the influence of compounding engines on economy. 2000 w. Power—March 8, 1910. No. 12173.

Power Plants.

Johnson and Johnson's New Power Plant. Warren O. Rogers. Illustrated description of a plant in New Brunswick, N. J., furnishing power to manufacture surgical dressings and hospital supplies. 2500 w. Power—March 29, 1910. No. 12745.

Composite Power Generation. J. M. W. Kitchen. Gives reasons for the restricted use of gas power, and reasons favoring the composite use of steam and gas. 1500 w. Power—March 22, 1910. Serial. 1st part. No. 12511.

See also Producer Gas, under Combustion Motors.

Shafting.

Line-Shaft Efficiency, Mechanical and Economic. Henry Hess' paper on this subject is discussed. 5000 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12354 F.

Turbo-Compressors.

Tests of a Jaeger Turbo-Compressor (Versuche an einem Turbinengebläse der Bauart C. H. Jaeger). H. Mitter. Describes in detail the machine and the tests and gives results. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 5, 1910. No. 12609 D.

STEAM ENGINEERING.

Boiler Corrosion.

The Deterioration of Steam Boilers. Francis H. Davies. Discusses external and internal corrosion and their preventives. 1500 w. Prac Engr—Feb. 25, 1910. No. 12182 A.

Electro-Chemical Action and Boiler Corrosion. Editorial review of experiments carried out by Prof. C. F. Burgess, of the Univ. of Wis. 3000 w. Engng—Feb. 25, 1910. No. 12189 A.

Boiler Covering.

Notes on Boiler Covering. A. P. Strohmenger. Lectures delivered at the meeting of the Inst. of Marine Engrs. Discusses heat losses and the efficiency of coverings. 1500 w. Prac Engr—March 18, 1910. Serial. 1st part. No. 12724 A.

Notes on Boiler Covering. A. P. Strohmenger. Lecture before the Inst. of Marine Engrs. Discusses the properties of a desirable covering. 2500 w. Mech Engr—March 11, 1910. No. 12390 A.

Boiler Design.

The Best Form of Longitudinal Joint for Boilers. Discussion of F. W. Dean's paper. 1700 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12355 F.

Boiler Efficiency.

Relative Efficiencies of Yorkshire and Lancashire Boilers. Charles Travis. A comparison of these types and details of tests made. 2500 w. Boiler Maker—March, 1910. No. 12228.

Boiler Explosions.

Boiler Explosions. Charles L. Hubbard.

Considers the causes of boiler explosions and the means taken to prevent them. 1500 w. Elec Rev, N Y—March 12, 1910. No. 12253.

Boiler Failures.

The Diseases of Boilers. A summary of the results of investigations of the Hartford Steam Boiler Inspection & Insurance Co. as given by F. S. Allen in an address before the New England Assn. of Elec. Lgt. Engrs. 3500 w. Eng Rec—March 19, 1910. No. 12367.

Boiler Feeding.

Feeding Water to Steam Boilers. J. E. Terman. Illustrated description of the usual boiler feeds, used in the United States, and the effects produced by them. 2200 w. Power—March 15, 1910. No. 12267.

Operation of Boiler Feed Systems. William F. Fischer. Considers points in the design and operation of feed-water systems for modern condensing and non-condensing plants. 4000 w. Power—March 8, 1910. No. 12170.

Boiler Furnaces.

The Thermal Conductivity of Fire-Clay at High Temperatures. J. K. Clement and W. L. Egy. Investigations to obtain information concerning the loss of heat through the walls of boiler furnaces. Ills. 5500 w. Univ of Ill, Bul 36—Aug. 2, 1909. No. 12535 N.

An Improved Mechanically-Stoked Furnace. Illustrates and describes a system of grates, operated either mechanically or by hand-firing. 1800 w. Prac Engr—Feb. 18, 1910. No. 12056 A.

Boiler Management.

Irregularities in Furnace Fires. Arthur S. Mann. Arrangement favoring the placing of technical men in charge of the fireroom and stokers. 2000 w. Engineering Magazine—April, 1910. No. 12688 B.

CO^2 Percentages and Economical Firing. J. V. Hunter. Explains how carbon dioxide in flue gases was increased by careful firing and variation of draft with load. 2500 w. Power—March 22, 1910. No. 12510.

Boilers.

See Power Generation, under POWER AND TRANSMISSION.

Boiler Troubles.

Unstable Water Lines in Steam Boilers. C. L. Hubbard. Illustrates and describes various sources of trouble in heating boiler operation. 2000 w. Met Work—March 26, 1910. No. 12667.

Boiler Tubes.

Deformations of Fire Tubes (Déformations des Tubes foyers). B. Müller. Translated from the *Zeitschrift des Vereines deutscher Ingenieure*, May 15, 1909. Ills. 4500 w. Rev de Mécan—Feb., 1910. No. 12422 E + F.

Boiler Waters.

Water Supply and Treatment for Power Plant Purposes. William Miller Booth. From a paper before the Am W-Wks. Assn. Discusses soft and hard waters, saline, alkaline and acid waters, and methods of treatment. 4500 w. Munic Engng—March, 1910. No. 12325 C.

Condensers.

The Surface Condenser in Mining Power Plant. W. A. MacLeod. Explains the principles of design as applied to constant condensation, and applies the formulae to mixed plant consisting of constant and intermittent prime movers, giving test data of complex plant. Ills. 19500 w. Inst of Min & Met, Bul. 65—Feb. 10, 1910. No. 12322 N.

The Improvement in Design of Condensing Installations on Board of Sea-Going Vessels. Hans Vogel. Translation of an article on the design of marine condensing installations which appeared in *Zeit für das Gesamte Turbinenwesen*. Ills. 2000 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12698 H.

A New Condenser—Intake Tunnels. R. D. Tomlinson. Illustrated description of a condenser so designed that all the condensing apparatus, exclusive of piping, is placed entirely beneath the turbine and between the foundation columns. 2500 w. Power—March 22, 1910. No. 12509.

Engine Pistons.

The Calculation of Solid Pistons (Die Berechnung der Scheibenkolben). C. Pfleiderer. Mathematical discussion of their design. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1910. No. 12614 D.

Fuel Purchasing.

Purchase of Coal and Oil by the Cleveland Water Department. E. W. Bemis and C. F. Schulz. Describes methods giving a summary of specifications. Discussion. 2000 w. Pro Am W-Wks Assn—1909. No. 12755 N.

Fuels.

Chemical Data as Related to the Power Plant. S. W. Parr. Discusses the function that chemistry may perform in the study of the fuel problem. 3300 w. Pro Am W-Wks Assn—1909. No. 12756 N.

Bagasse and Bagasse Furnaces. Editorial review of a bulletin recently issued by the Louisiana State Univ. detailing results of a number of tests carried out on actual installations in Louisiana and Cuba. 2500 w. Engng—Feb. 18, 1910. No. 12060 A.

See also Briquetting, under MINING AND METALLURGY, COAL AND COKE.

Fuel Testing.

Federal Investigations of Mine Accidents, Structural Materials, and Fuels, at the United States Testing Station, Pittsburg, Pa. Herbert M. Wilson. Explains the character of the work and the methods adopted, giving summary of results. Ills. 38500 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12650 E.

Government Investigations and Test of Fuels. Address by Herbert M. Wilson, with discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1910. No. 12568 D.

The Use and Abuse of Fuels. H. M. Wilson. Discusses the U. S. Government's methods for testing and purchasing fuels. General discussion follows. 9800 w. Pro Am W-Wks Assn—1909. No. 12757 N.

Heat Transmission.

Heat Transmission and Transmitters. A. B. Willits. Describes the construction and principle of the "S and K" corrugated film heater. 1500 w. Jour Am Soc of Nav Engrs—Feb., 1910. No. 12697 H.

Mechanical Stokers.

See Boiler Furnaces, under Steam Engineering.

Steam Piping.

Expansion of Pipes. Ralph C. Taggart. Considers methods of caring for expansion in steam piping or other pipes subject to considerable change of temperature. 6000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12658 E.

Thermodynamics.

On the Definition of the Ideal Gas. Edgar Buckingham. Explains the nature and purpose of the definition and its use in thermodynamic reasoning. 5000 w. Bul Bureau of Stand—Feb., 1910. No. 12564 N.

The Second Law of Thermodynamics; Its Basis in Intuition and Common Sense. Prof. W. S. Franklin. An account of this fundamental principle. 8400 w. Pop Sci M—March, 1910. No. 12296 C.

Turbine Efficiency.

Losses in the Blades of Free-Jet Steam Turbines (Verluste in den Schaufeln von Freistrahldampfturbinen). Nikolai Briling. A theoretical discussion and results of experimental investigations. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 12, 1910. No. 12611 D.

Turbines.

Elementary Principles of Steam Turbine. William E. Snow. Explains the fundamental principles of commercial impulse turbines and compares them with hydraulic turbines. Ills. 4000 w. Power—March 8, 1910. No. 12168.

A New Turbine. Illustrated detailed description of steam turbines of the so-called combined velocity and pressure type, being manufactured by Dick, Kerr & Co., Ltd. 3000 w. Engr, Lond—Feb. 18, 1910. No. 12064 A.

The Barbegat Steam Turbine (Die Dampfturbine Bauart Barbezat). P. André. Illustrated detailed description of the theory and design. Serial. 1st part. 3300 w. Die Turbine—Feb. 20, 1910. No. 12479 D.

Turbine Tests.

Test of a 15000 KW. Steam-Engine-Turbine Unit. H. G. Stott. R. J. S. Pigott. Gives the reasons for adopting this type of apparatus, with a brief description of the plant and summary of results, with data acquired during tests. Tables and curve sheets. 2500 w. Jour Am Soc of Mech Engrs—March, 1910. No. 12351 F.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Telpherage Systems for Foundries. Alfred Gradenwitz. Illustrates and describes modern German methods of handling raw material in foundry storage yards and its conveyance to the cupola. 1200 w. Foundry—March, 1910. No. 12092.

A Telpherage System for Handling River Traffic. Illustrated description of a handling plant near Memphis, built by the Illinois Central R. R. 1200 w. Eng Rec—Feb. 26, 1910. No. 12034.

Bleichert Electric Aerial Tramways (Bleichertsche Elektrohängebahnen). S. Abt. Describes a number of recent installations in industrial plants. Ills. 3500 w. Schweiz Bau—Feb. 12, 1910. No. 12475 B.

Elektromechanical and Electromagnetic Devices for Electric Aerial Tramways (Elektromechanische und elektromagnetische Einrichtungen für die Zugdeckung und das Windwerk von Motorlaufkatzen bei Elektrohängebahnen). Hans Wettich. A description of the electrical arrangement of tramway carriers. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—Feb. 17, 1910. No. 12498 D.

Cableways.

Aerial Coal-Conveying Ropeway at Barnsley Main Colliery. Illustrates and describes an interesting ropeway on the endless running rope system. 700 w. Ir & Coal Trds Rev—March 11, 1910. No. 12507 A.

Car Dumping.

See Freight Cars, under RAILWAY ENGINEERING Motive Power and Equipment.

Coal Handling.

Practical Considerations in Coal Handling for Pumping Plants. S. Bent Russell. Suggestions for determining the best system. General discussion. 2000 w. Pro Am W-Wks Assn—1909. No. 12758 N.

Transport Devices in the Reisholz Central Station (Die Transporteinrichtungen der Zentrale des Rheinisch-Westfälischen Elektrizitätswerkes zu Reisholz). Hubert Hermanns. Illustrated description of the coal-handling equipment. 1700 w. Elektrotech u Maschinenbau—Feb. 13, 1910. No. 12605 D.

See also Coaling Stations, under RAILWAY ENGINEERING, Permanent Way and Buildings.

Cranes.

The Jordan Compressed-Air Brake and Coupling for Foundry Cranes (Die Jordan-Druckluftbremse und -Kupplung an Giessereikranen). K. Behrend. Illustrated description and discussion. 1800 w. Giesserei-Zeit—Feb. 15, 1910. No. 12465 D.

Freight Handling.

Economical Freight Transference at Railway Terminals and Shipping Docks. H. McL. Harding. An illustrated study of the situation and a discussion of mechanical systems and their requirements, terminal improvements, etc. 12500 w. Eng News—March 3, 1910. No. 12107.

See also Telpherage, under Transporting and Conveying.

Industrial Locomotives.

The Electric Storage Battery Locomotive. Warren H. Miller. Gives conclusions based on observations of practical operation in industrial service. Deals with the selection of proper equipment, the care of battery and locomotive, and the facilities for charging. 3500 w. Elec Wld—March 31, 1910. No. 12629.

Lifting Magnets.

Lifting Magnets. Calls attention to points in their design. 600 w. Prac Engr—Feb. 25, 1910. No. 12181 A.

MISCELLANY.

Aeronautics.

New Aeroplanes at Home and Abroad. Illustrates and describes recent types. 3000 w. Sci Am—March 19, 1910. No. 12347.

Aëroplane Stability. G. H. Bryan. An account of the peculiarities of aëroplane stability as deduced from the author's work, and a comparison with Ferber's and Lanchester's methods. 3000 w. Nature—March 3, 1910. No. 12298 A.

The Stability of Flying Machines. Herbert Chatley. Discusses the principles in connection with stability, considering the automatic single-surface glider in the present article. 2000 w. Engng—March 4, 1910. Serial. 1st part. No. 12287 A.

The Sustentation of Aeroplanes (Sur la Sustentation des Aéroplanes). H. Alexandre. Mathematical outline of the theory of the action of the air on plane and curved moving surfaces. 3000 w. Bul Sci d l'Assn des Elèves—Jan., 1910. No. 12405 D.

The International Aero and Motor-Boat Exhibition. An illustrated account of the most striking features of the show. 6500 w. Engng—March 18, 1910. Serial. 1st part. No. 12732 A.

Exhibits at the Aero and Motor-Boat Exhibition at Olympia. Illustrates and describes petrol-electric generators, and two-cycle petrol engines. 2500 w. Engng—March 11, 1910. No. 12396 A.

Letter Mailer.

Automatic Machinery as Used in Office Work. R. S. Bayard. Illustrated description of a machine for mailing letters at the rate of 200 a minute. 2200 w. Am Mach—Vol. 33. No. 9. No. 12122.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

See Fuel Testing, under MECHANICAL ENGINEERING, Steam Engineering.

Alaska.

Controller Bay Coal Field. George Watkin Evans. An illustrated article giving the location, extent, and quality of these coal fields in Alaska, and proposed transportation routes. 4500 w. Mines & Min—March, 1910. No. 12081 C.

Briquetting.

The Fuel Briquetting Industry. Charles L. Wright. An illustrated discussion of the possibilities and the principal briquetting processes. This first part considers plants, materials, etc. 3000 w. Engineering Magazine—April, 1910. No. 12684.

A Commercial Fuel-Briquette Plant. W. H. Blauvelt. Illustrated description of the briquette-plant of the Solvay Process Co. and the Semet-Solvay Co. at Detroit, Mich., with details of operation. 3500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12693 F.

Coal Cutting.

The Advantages of Machine Mining. Floyd W. Parsons. Compares different types of undercutting machines, discussing various methods of undercutting a coal seam. Ills. 2500 w. Eng & Min Jour—March 19, 1910. No. 12374.

Coke-Oven Effluents.

The Pollution of Streams by Spent Gas Liquors from Coke Ovens and the Methods Adopted for Its Prevention. Dr. H. Maclean Wilson. Abstract of a paper read before the Midland Inst. of Min., Civ., & Mech. Engrs. on the treatment of coke-oven effluent. 3000 w. Col Guard—Feb. 25, 1910. No. 12187 A.

Coke Ovens.

The Mackay-Seymour System of Coke Ovens and By-Products Plants. Illustrates and describes an installation at Skelmanthorpe, Eng. 2300 w. Col Guard—Feb. 25, 1910. No. 12186 A.

Electric Power.

Rules for the Installation and Use of Electricity in Mines. Eustace E. Baker. Abstract of paper before the Manchester

Geol. & Min. Soc. Suggestions for the amendment of the existing rules in Great Britain. 6500 w. Col Guard—March 18, 1910. No. 12730 A.

England.

Brodsworth Main Collieries. Illustrated description of colliers near Doncaster, England, and their equipment. 2000 w. Ir & Coal Trds Rev—Feb. 25, 1910. No. 12197 A.

Explosions.

Dust-Explosions in Coal Mines. George S. Rice. Information concerning investigations carried out by the Technologic Branch of the U. S. Geological Survey. 1500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12692 F.

The Primero Disaster. R. L. Herrick. Illustrated description of the mines and conditions, and the action of the explosive force. 10500 w. Mines & Min—March, 1910. No. 12083 C.

Explosives.

Permissible Explosives as Used in Coal Mines. J. J. Rutledge. Directions for the intelligent use of the new explosives, and the economy resulting. 5600 w. Eng & Min Jour—March 26, 1910. No. 12668.

Mining.

The Small Coal Question. Discusses the demand of the South Wales miners that payment be made the collier for small coal. 5000 w. Col Guard—March 18, 1910. No. 12728 A.

The Multiple Shift System of Working in Northumberland and Durham. H. F. Bulman. Describes this system and the annoyance from the Eight Hours Act. 2500 w. Col Guard—March 11, 1910. No. 12391 A.

Safety Appliances in German Mines. R. W. Voigt. Information concerning the amount of air required by law; blasting, safety chambers and their equipment. 2400 w. Mines & Min—March, 1910. No. 12082 C.

Peat.

Some Commercial Aspects of Peat as a Source of Chemical Products. Charles A. Davis. Discusses what is being done in Europe to recover valuable by-products from peat, and as a source of producer-gas, and the commercial possibilities for the United States. 7500 w. Ec-Geol—Jan., 1910. No. 12534 D.

Safety Lamps.

Various Types of Safety Lamps. J. B. Marsaut. Abstract translation from the *Bul. de l'Indus. Min.* Illustrates and describes types, considering their comparative safety. 2500 w. Sci Am Sup—March 12, 1910. No. 12226.

Acetylene Safety Lamps (Azetylen-Sicherheitslampen). Herr Beyling. Describes a number of types and discusses their advantages. Ills. 6000 w. Glückauf—Feb. 19, 1910. No. 12468 D.

Siberia.

Coal-Mining Methods in Siberia. Information from a paper by Robert M Percy concerning methods of working, general conditions, etc. 1500 w. Eng & Min Jour—March 19, 1910. No. 12375.

COPPER.

Chile.

The Copper Mines and Smelting Works of Naltagua, Santiago, Chile. F. A. Sundt. Abstract translation. Describes the mines, smelting works, etc. 2000 w. Min Jour—March 19, 1910. No. 12726 A.

Converters.

Recent Patents for Basic-Lined Copper Converters. Richard H. Vail. An illustrated review of the Peirce and Smith converter patents. 2000 w. Eng & Min Jour—March 12, 1910. No. 12262.

Michigan.

The Michigan Copper Mines and Methods. R. B. Brinsmade. Map and description of the geology, topography and development. Ills. 3500 w. Min Wld—March 12, 1910. Serial. 1st part. No. 12259.

Montana.

See Ore Deposits, under MISCELLANY.

Nevada.

The Bristol Mines. Stephen L. Goodale. Illustrated description of a typical desert copper-silver mine near Pioche, Nev. 3000 w. Mines & Min—March, 1910. No. 12090 C.

The Mines of the Ely District of Nevada. Leroy A. Palmer. An illustrated review of this old gold and silver district which has recently become one of the greatest copper producing districts of the country. 5000 w. Min Wld—March 5, 1910. No. 12158.

Report to Stockholders of Ely Central Copper Co. Walter Harvey Weed. Illustrated description of the property examined, stating the conclusions reached. 3000 w. Min Wld—Feb. 26, 1910. No. 12039.

See also Copper, under ORE DRESSING AND CONCENTRATION.

Refining.

Sampling Anode-Copper, With Special Reference to Silver-Content. William Wraith. An investigation of methods used at the Washoe smelter, Anaconda, Mont. 1200 w. Bul Am Inst of Min Engrs—March, 1910. No. 12691 F.

Smelter Fumes.

Elimination of Smelter Fume. Leroy A. Palmer. Information concerning the successful neutralization of the fume at the plant of the U. S. Smelting Co., Midvale, Utah. Ills. 5000 w. Mines & Min—March, 1910. No. 12088 C.

Sprague Process for Treating Furnace Gases. C. B. Sprague. Describes this process which is used successfully at Midvale, Utah. 2000 w. Eng & Min Jour—March 5, 1910. No. 12156.

Smelting.

The Uses and Abuses of Small Smelting Plants. Herbert Lang. Discusses causes of failure, and some that may be avoided, the mechanical features and the smelting mixture. 4500 w. Eng & Min Jour—Feb. 26, 1910. No. 12035.

GOLD AND SILVER.

Alaska.

See Dredging, under Gold and Silver.

Australia.

Deep Lead Mining in New South Wales. E. W. Nardin. Sketch plan, and description of the Main Ridge auriferous deep lead system near Rockley (N. S. W.). 1800 w. Aust Min Stand—Feb. 9, 1910. No. 12305 B.

Mount Flora Gold and Mineral Field. Lionel C. Ball. An illustrated description of the geography, geology, ore deposits, mining, etc. 10500 w. Queens Gov Min Jour—Feb., 1910. Serial. 1st part. No. 12303 B.

California.

Hoag District, California. Norman C. Stines. Information concerning the geology, ore deposits, development, etc. Ills. 2500 w. Min & Sci Pr—March 12, 1910. No. 12336.

See also Placers, under Gold and Silver.

Cyaniding.

Commercial Sodium and Potassium Cyanide. W. J. Sharwood. Considers relative merits as shown by chemical analysis, errors due to incorrect standards, etc. Bibliography. 3000 w. Eng & Min Jour—March 19, 1910. No. 12373.

Notes on the Precipitating Effects of Substances Containing Various Forms of Carbon and Cellulose on Cyanide Solutions Containing Gold and Silver. A. J. Clark and W. J. Sharwood. Gives results of a series of experiments and observations, with other information. 3000 w. Jour Chem, Met, & Min Soc of S Africa—Jan., 1910. No. 12276 E.

Cyanidation of Concentrate. A. E. Drucker. Illustrates and describes a combined air-agitator and continuous leaching vat, explaining it's economy and efficiency for treating high grade slime. 2000 w. Min & Sci Pr—March 19, 1910. No. 12631.

The Silver Cyanide Mill of the San Rafael of Anexas Co., Pachuca. E. Girault. Read before the Inst. Mexicano de Mines y Met. Illustrated description of the mills, their equipment, and the treatment. 1200 w. Met & Chem Engng—March, 1910. No. 12204 C.

Dredging.

Dredging Nome Beach Sands. Illustrates and describes a type of dredge that is saving gold from underwater sands. 1800 w. Mines & Min—March, 1910. No 12087 C.

Submarine Gold Dredging at Nome, Alaska. Elmer E. Carey. Discusses plans for dredging the rich fields of the Arctic Ocean along the Nome coast. 1500 w. Min Wld—March 19, 1910. No. 12382.

Pony Dredges in Alaska. William H. Washburn. A brief review of plans tried in adapting machinery to placer mining. Ills. 2000 w. Min & Sci Pr—March 5, 1910. No. 12257.

Mexico.

Prospecting in Chihuahua. R. H. Burrows. Describes this important mining region, giving a map showing the geology of this district. 1500 w. Min & Sci Pr—March 12, 1910. No. 12337.

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The Montana-Tonopah Mine and Mill, Nevada. A. H. Martin. Illustrated detailed description. 2000 w. Min Wld—March 12, 1910. No. 12260.

Reopening of the Mexican Mine, Comstock Lode. Whitman Symmes. An illustrated account of the devolopment and description of the geology. 2500 w. Min & Sci Pr—March 19, 1910. No. 12632.

Nicaragua.

Piz-Piz District, Nicaragua. W. A. Connelly. Map and brief account of this gold mining district. 2000 w. Min & Sci Pr—March 5, 1910. No. 12256.

Norway.

Kongsberg Silver Mines, Norway. H. L. Lawrence. An account of one of the oldest mining centers in Europe, where native silver is found in persistent quantities. 2500 w. Min Jour—March 5, 1910. No. 12282 A.

Placers.

Dredging and the Sampling of Placer Ground. A. P. Rogers. Brief description of methods of testing and preliminary sampling. 2000 w. Eng & Min Jour—March 12, 1910. No. 12261.

Santa Clara River Placers. Claude E. Jamison. Brief account of this part of California, said to be the district where gold was first discovered. 1500 w. Min & Sci Pr—March 5, 1910. No. 12258.

IRON AND STEEL.

Bessemer Converters.

The Design of Basic Bessemer Converters (Einige Gesichtspunkte für die Konstruktion der Thomasbirne). W. G. Gillhausen. A review of progress since 1875. Ills. 3200 w. Stahl u Eisen—Feb. 23, 1910. No. 12463 D.

Blast-Furnacce Gas.

Recent Installations for the Utilization of Blast-Furnace and Coke-Oven Gases (Récentes Installations pour l'Utilisation des Gaz de haut Fourneau et de Fours à Coke). A brief review of gas-engine progress in Germany. Ills. 1800 w. L'Elecn—Feb. 12, 1910. No. 12429 D.

Blast-Furnace Practice.

Advantages of Enriched Air Blast. Jos. W. Richards. The effect air enriched in oxygen can have upon the working of a blast furnace is considered. 1000 w. Met & Chem Engng—March, 1910. No. 12203 C.

The Combustion-Temperature of Carbon and Its Relation to Blast-Furnace Operation. Clarence P. Linville. A study of the relations of blast-temperature, moisture-content, and combustion temperature. 3300 w. Bul Am Inst of Min Engrs—March, 1910. No. 12694 F.

Blast-Furnace Slags.

Black and Blue Blast-Furnace Slags (Schwarze und blaue Eisenhochofenschlacken). Hans Fleissner. An important investigation of the coloring of slags. Ills. Serial. 1st part. 2800 w. Oest Zeitschr f Berg u Hüttenwesen—Feb. 12, 1910. No. 12466 D.

Blowing Engines.

A Notable Gas Engine Installation. Brief illustrated description of the Tod gas-driven blowing engines at the Carnegie Steel Co.'s works at Youngstown, Ohio. 600 w. Ir Age—March 17, 1910. No. 12301.

British Columbia.

Iron Ore Deposits of Vancouver and Texada Islands, British Columbia. Einar Lindeman. Description of districts. 5 maps. 9000 w. Can Dept of Mines, 1910—No. 47. No. 12528 N.

Cowper Stoves.

Calculation of Hot-Blast Stoves Based on the Conductivity of Refractory Bricks (Le Calcul des Appareils à Air chaud basé sur la Conductibilité des Briques réfractaires). B. Osann. An exhaustive treatment. Ills. 8500 w. Rev de Métal—Feb., 1910. No. 12414 E + F.

Dry-Air Blast.

Drying Blast with Calcium Chloride. Illustrates apparatus and describes the process. 1500 w. Ir & Coal Trds Rev—March 11, 1910. No. 12505 A.

Electrometallurgy.

The Electric Furnace, with Special Reference to the Manufacture of High-Class Steel. Joh. Harden. Read before the Rugby Engng. Soc. Reviews the development of the electric furnace as used for metallurgical purposes. 4200 w. Mech Engr—Feb. 25, 1910. No. 12185 A.

The Electric Furnace. J. Harden. Abstract of a paper read before the Rugby Engng. Soc. Discusses the advantages and disadvantages of various types, giving typical results, metallurgical and financial, and refers to the effect of power factor. 2200 w. Elect'n, Lond—March 18, 1910. No. 12717 A.

The Electric Production of Iron from Iron Ore. Report by Lars Yngström on experiments made at Domnarfvet Ironworks, Sweden, to find a suitable reduction furnace for the continuous production of pig iron. Ills. 2000 w. Engr, Lond—Feb. 25, 1910. Serial. 1st part. No. 12196 A.

Ferro-Alloys.

Manufacture and Transport of Ferrosilicon. Useful and interesting information from a report issued by the British Local Government Board, concerning the nature of the gases evolved and the possibilities of preventing danger. Ills. 4000 w. Met & Chem Engng—March, 1910. No. 12207 C.

Germany.

The Development of the Iron Industry in Germany (Die Entwicklung der Eisenindustrie in Deutschland). W. Mathesius. A historical and statistical review. Ills. 6500 w. Stahl u Eisen—Feb. 9, 1910. No. 12456 D.

Prices of Raw and Finished Materials in Germany from 1887 to 1909. A series of charts showing prices in the German iron industry. Stahl u Eisen—Feb. 16, 1910. No. 12461 D.

Ingots.

Thermal Treatment of Steel Ingots. J. F. Springer. Illustrated discussion of methods aiming to prevent pipes and segregation. 1800 w. Sci Am—March 26, 1910. No. 12644.

Quebec.

Canadian Iron Ores Along the Ottawa and Gateneau Rivers. Editorial discussion of these ore deposits. 2000 w. Engng—March 18, 1910. No. 12734 A.

Rolling Mills.

A Three-High Steel Rolling Mill. R. L. Cochran. Describes a type used for rolling rails, structural shapes, plates, flats, rounds, square or the like. Ills. 1800 w. Sib Jour of Engng—March, 1910. No. 12552 C.

Recent Roll Trains (Ueber neuere Walzenstrassen). Describes recent plants of German origin in various parts of the world. Ills. 3800 w. Stahl u Eisen—Feb. 23, 1910. No. 12462 D.

A Study of Rolled Material at the Various Stages of Manufacture (Untersuchung von Walzmaterial in den verschiedenen Verarbeitungsstufen). A report of tests at the Aachen Technical High School. Ills. 1700 w. Stahl u Eisen—Feb. 16, 1910. No. 12460 D.

Steel Works.

The Hungarian State Diosgyör Steel Works. J. B. Van Brussel. Illustrated description of a European state-operated industrial establishment. 2000 w. Ir Trd Rev—March 17, 1910. No. 12332.

LEAD AND ZINC.

Missouri.

Operations of the Doe Run Lead Company. Albert H. Fay. Describes the mining and milling methods. A 2000-ton concentrating plant; producer-gas engines and electric generators, and compressed air haulage. Ills. 2500 w. Eng & Min Jour—March 9, 1910. No. 12372.

Reclaiming Zinc and Lead Ores. Lucius

L. Wittich. An account of methods of stripping worked out mines in the Joplin district, and the reworking of tailings. Ills. 3000 w. Mines & Min—March, 1910. No. 12089 C.

Geology of Southeast Missouri Lead District. H. A. Wheeler. A review of Dr. E. R. Buckley's report on this district. 2000 w. Eng & Min Jour—Feb. 26, 1910. No. 12038.

Zinc Smelting.

Use of Carbonaceous Filters in Smelting of Zinc. C. O. Bannister. Read before the Inst. of Metals, London. Describes the Hopkins' process, stating the advantages claimed. 2000 w. Min Wld—March 5, 1910. No. 12160.

Recovery of Zinc from the Zinc Slags of the Lower Harz Smelters (Die Gewinnung des Zinks aus den Zinkhaltigen Schlacken der Unterharzer Hüttenbeitriebe). Herr Pape. A brief description of a recently developed process for utilizing zinc slags. 2000 w. Glückauf—Feb. 19, 1910. No. 12469 D.

MINOR MINERALS.

Manganese.

Cost of Mining Manganese Ore in India. Abstracted from a report on "The Manganese Ore Deposits of India" by L. Leigh Fermon. Remarks applying particularly to the Central Provinces. 4500 w. Ir & Coal Trds Rev—March 11, 1910. No. 12504 A.

Marble.

Some Remarkable Fine Marble Quarries in Colorado. Arthur Lakes. Information concerning remarkable deposits comparing favorably with the finest in Europe. Ills. 1500 w. Min Wld—March 19, 1910. No. 12381.

Oil.

Early Waste of Petroleum. Xeno W. Putnam. An account of the wasteful methods employed in the oil industry of western Pennsylvania in its early history. Ills. 2000 w. Mines & Min—March, 1910. No. 12086 C.

Oil Fields of Peru. Lindell T. Bates. Description and information concerning the oil beds and their development. Ills. 1200 w. Yale Sci M—March, 1910. No. 12648 C.

Joint Report on the Bituminous, or Oil-Shales of New Brunswick and Nova Scotia. Also, on the Oil-Shale Industry of Scotland. Part I. Economics. Part II. Geology. R. W. Ells. Ills. 30000 w. W Can Dept of Mines, 1910—Nos. 55 and 1107. No. 12529 N.

Vanadium.

Vanadium. Its Occurrence, Preparation and Uses. Information concerning vanadium minerals and their distribution, extraction and industrial uses. 3000 w. Bul Imp Inst—Vol. VII. Nov. 4, 1909. No. 12297 C.

MINING.

Accidents.

Fatal Accidents in American Metal Mines. Frederick L. Hoffman. A comparison of international statistics, and calling attention to the need of effective legislation. 2500 w. Eng & Min Jour—March 5, 1910. No. 12155.

Drills.

Rock Drills and Their Latest Development (Die Gesteinbohrmaschinen und ihre neuere Entwicklung). Fr. Herbst. A review of machine mining methods, rock drills and their applications, etc. Ills. Serial. 1st part. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 19, 1910. No. 12613 D.

Rock Drill Bits. T. H. Proske. On the selection and treatment of the bits. Ills. 2300 w. Min & Sci Pr—March 5, 1910. No. 12255.

Earth Shakes.

Earth-Shakes in Mining Districts. Charles Davison. Describes their characteristic features and gives a theory of their origin. 2000 w. Min Jour—March 12, 1910. No. 12388 A.

Electric Hoisting.

Large Electric Hoisting Plants. Wilfred Sykes. Describes methods used by the author for the determination of load diagrams and also the characteristics of balancing systems and their economy. Ills. 7000 w. Pro Am Inst of Elec Engrs—March, 1910. No. 12704 F.

Electric Power.

The Causes and Means of Preventing Electrical Accidents in Mines. An inquiry undertaken by the Inst. of Min. Elec. Engrs. This first article discusses electric shocks. 1600 w. Col Guard—Feb. 18, 1910. Serial. 1st part. No. 12059 A.

Engineering Ethics.

Professional Ethics. Victor G. Hills. Suggestions offered as a contribution to the discussion invited by John Hays Hammond. 5000 w. Bul Am Inst of Min Engrs—March, 1910. No. 12090 F.

Hoisting.

Stationary versus Moving Hoisting Plants. J. F. Jackson. A discussion of open-cut mining. 1200 w. Eng & Min Jour—March 5, 1910. No. 12157.

Hoisting Cages.

New Safety Cage at Mount Morgan (Q.). Brief illustrated description of a cage and safety gear for transporting men and supplies at the shaft of the Mount Morgan G. M. Co. (Q.). 500 w. Aust Min Stand—Feb. 2, 1910. No. 12304 B.

Hoisting Engines.

The "A. B. S." Brake for Winding Engines. Illustrated description. 1000 w. Ir & Coal Trds Rev—March 11, 1910. No. 12508 A.

Mine Cars.

Ball and Roller Bearings for Mine Cars (Kugel- und Rollenlagerradsatze für Forderwagen). Herr Schulte. Discusses the reduction in friction and the economy. Ills. 2000 w. Glückauf—Feb. 19, 1910. No. 12470 D.

Mine Locomotives.

See Industrial Locomotives, under MECHANICAL ENGINEERING, Transporting and Conveying.

Mine Roofs.

The Strength of Mine Roofs. R. Dawson Norris Hall. Considers the behavior of the mine roof under its own load, the strength of the materials composing it, the action of the forces that cause breaks. Ills. 2500 w. Mines & Min—March, 1910. No. 12084 C.

Problems.

Application of Descriptive Geometry to Mining-Problems. Joseph W. Roe. Explains a number of useful applications. 3500 w. Bul Am Inst of Min Engrs—March, 1910. No. 12689 F.

Quarrying.

Cornish Granite. Illustrates and describes quarries at Penryn, near Falmouth, Cornwall. 1500 w. Quarry—March, 1910. No. 12191 A.

Shafts.

The Strength of Concrete and Reinforced Concrete Shaft Linings (Die Festigkeit von Schachtausmauerungen aus Beton und Eisenbeton). E. Elwitz. Mathematical. Ills. 2500 w. Deutsche Bau—Feb. 16, 1910. No. 12473 B.

Shaft Sinking.

Methods and Cost of Sinking the Brier Hill Concrete-Lined Shaft, Michigan. Arranged from a paper by William Kellev, in the Pro. of the L. Superior Min. Inst. Plans and description. 2000 w. Engng-Con—March 2, 1910. No. 12099.

Signal Systems.

Signalling Instruments for Mines. Illustrates and describes a system installed by the Adnil Elec. Co., Ltd. 1500 w. Col Guard—March 11, 1910. No. 12392 A.

Sorting.

Sorting: An Economic Problem on the Rand. C. O. Schmitt. Discusses whether it is possible to sort out barren rock only; and, if so, whether it can be done at a profit. Also discussion. Ills. 8500 w. Jour S African Assn of Engrs—Feb., 1910. No. 12711 F.

Stoping.

Stoping Methods in Mines of Ducktown Basin. John Tyssowski. Underhand stoping is generally used, and small pillars of ore left for support. Ills. 1500 w. Eng & Min Jour—Feb. 26, 1910. No. 12037.

Ventilation.

The New Ventilation Installations at the Mines of the Clausthal District (Die neuen Ventilatoranlagen auf den Gruben der Königl. Berginspektion Clausthal). Herr Saubrey. Describes a Rateau turbo-fan installation. Ills. 2000 w. Glückauf—Feb. 5, 1910. No. 12467 D.

ORE DRESSING AND CONCENTRATION.

Classification.

See Tube Mills, under Ore Dressing and Concentration.

Coal Separators.

A New Separator for the Removal of Slate from Coal. V. H. Wilson. Reviews methods and machines used in removing slate and handling coal with as little waste as possible, and describes a new separator and its operation. 1500 w. Yale Sci M—March, 1910. No. 12649 C.

Copper.

The Steptoe Concentrating Plant, Nevada. Leroy A. Palmer. Illustrated detailed description of the plant and its operation. 4500 w. Min Wld—March 19, 1910. No. 12380.

Filters.

The Oliver Continuous Filter at Minas del Tajo. G. A. Tweedy and R. L. Beals. Illustrates and describes the construction and operation of these filters. 1000 w. Eng & Min Jour—March 5, 1910. No. 12154.

Stamp Mills.

The Development of Heavy Gravitation Stamps. Remarks by C. O. Schmitt on the paper by W. A. Caldecott. Ills. 5000 w. Inst of Min & Met, Bul. 65—Feb. 10, 1910. No. 12321 N.

Tube Mills.

Pulp Classification and Tube Mill Efficiency. From a report by V. B. Sherrod on some features of research work at the Guerrero Mill, Pachuca, Mex., particularly in pulp classification and the efficiency of tube-mill work. 1500 w. Met & Chem Engng—March, 1910. No. 12208 C.

Zinc Milling.

Horwood Process for Separating Zinc Sulphides. Donald Clark. Explains the principle of the process. Ills. 1200 w. Eng & Min Jour—Feb. 26, 1910. No. 12036.

MISCELLANY.

India.

The Economic and Productive Minerals of British India. Abstract of a lecture by Mr. W. H. Pickering, before the Birmingham Univ. Min. Soc. 1200 w. Col Guard—March 4, 1910. No. 12286 A.

Ore Deposits.

The Fractional Precipitating of Sulphides. Roger C. Wells. An experimental study, discussing results. 3000 w. Ec-Geol—Jan., 1910. No. 12530 D.

Oxidation of Sulphides. H. A. Buchler and V. H. Gottschalk. An account of experiments to determine whether or not marcasite and pyrite are the only sulphides acting as an accelerator of oxidation. 2000 w. Ec-Geol—Jan., 1910. No. 12533 D.

Superficial Alteration of the Butte Veins. Reno H. Sales. Describes the character of the outcrops of the Butte copper veins. 2200 w. Ec-Geol—Jan., 1910. No. 12531 D.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

Railway Signaling in America. J. S. Hobson. Treats only of visual signals for train control. Ills. 3500 w. Cassier's Mag—March, 1910. Special No. No. 12517 D.

Power Railway Signaling. J. F. Gairus. An illustrated account of current British practice. 6500 w. Cassier's Mag—March, 1910. Special No. No. 12518 D.

Studies in Circuits as Applied to Signaling. James H. Cormick. An illustrated series of lessons in the development of the circuits used in railway signaling. 3500 w. Sig Engr—March, 1910. Serial. 1st part. No. 12341.

Foreign Current and Its Effect on Track Circuits. Describes conditions often encountered in automatic signal work and means of preventing interference with signal operation. Ills. 1000 w. Sig Engr—March, 1910. No. 12342.

Lightning Arresters for Signal Apparatus. A. G. Wilson. Discusses the principles of lightning arrester design for signal service. 2000 w. Sig Engr—March, 1910. No. 12338.

Standard Rules and General Instructions for the Guidance of Foremen on Signaling and Interlocking Construction. R. A. Becker. 2000 w. Sig Engr—March, 1910. No. 12339.

The Multiple Unit Electric Interlocking Machine. Illustrated description of the design and operation. 1800 w. Sig Engr—March, 1910. No. 12340.

Cullybackey Interlocking and Tyer's Tablet. Illustrated description of the signaling at a typical station on a single-track railway in Ireland. 1200 w. Ry Age Gaz—March 25, 1910. No. 12642.

Signals.

Luminous Repeating or Advance-Indicating Railway Signals. Illustrated description of signals in use on the high-speed Brussels-Antwerp line, as a safeguard during fogs. 800 w. Eng News—March 10, 1910. No. 12216.

Train Despatching.

Train Despatching by Telephone. C. H. Gaunt. An account of its successful use on the A., T. & S. F. Ry. with general remarks. 1500 w. Elec Rev, N Y—March 12, 1910. No. 12254.

Train Speed.

Determination of Train Speed Without Measuring Instruments (Bestimmung von Fahrgeschwindigkeitenohne Messapparte). Hans A. Martens. An outline of a satisfactory method. 2000 w. Glasers Ann—Feb. 1, 1910. No. 12482 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Losses of Air Pressure. A general explanation of losses in the use of compressed air, and the effect on air brakes. 2000 w. Ry & Loc Engng—March, 1910. No. 12115 C.

Final Tests with the Automatic Vacuum Brake for Freight Trains (Schlussversuche mit der automatischen Vakuum-Güterzug-Schnellbremse). A final report on the tests carried out by the Austrian Government. Ills. Serial. 1st part. 9000 w. Glasers Ann—Feb. 1, 1910. No. 12480 D.

Car Maintenance.

Maintenance Cards. From a paper by R. W. Burnett, read before the Canadian Ry. Club. Describes the maintenance regulation cards used by the Canadian Pacific Ry. 2500 w. Ry Age Gaz—March 18, 1910. No. 12345.

Electrification.

The Electrification of the Lapland Railway. Editorial on the impending electrification of an important Swedish State Railway through Lapland, built originally for the transport of iron ore. 1500 w. Engng—March 11, 1910. No. 12398 A.

Electric Traction. George Gibbs. From a report to be presented before the Int. Ry. Cong. Discusses electric locomotives, the first cost of electrification, cost of operation, with general remarks. 4000 w. Ry Age Gaz—March 25, 1910. No. 12643.

The Cost of Electric Operation of Steam Railways. Concluding portion of a paper by George Gibbs, in the *Bul. of the Int. Ry. Cong.* for Jan., 1910. Deals with the design of electric locomotives and with the first cost and cost of operation of electrified steam railways. 4000 w. Eng News—March 31, 1910. No. 12776.

Freight Cars.

Handling of Bulk Railway Freight (Die Verladung von Massengütern im Eisenbahnbetrieb). Herr Schwabe. Discusses types of hopper cars and car-dumping devices. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 26, 1910. No. 12617 D.

Lighting Cars.

Benzin-Electric Motor Car for Lighting Purposes on the Swiss Railways (Selbstfahrender benzin-elektrischer Beleuchtungswagen der S. B. B.). M. Messer, Describes a car containing a lighting generator driven by a benzin motor used for tunnel examinations, illuminating scenes of accidents, etc. Ills. 1800 w. Schweiz Bau—Feb. 26, 1910. No. 12478 B.

Locomotive Boilers.

Notes on Locomotive Boiler Failures. J. H. Heltzel. Illustrated discussion of failures due to faulty design. 2000 w. March, 1910. No. 12230.

Locomotive Crank Axles.

A Three-Part Crank Axle (Dreiteilige Kurbelachse). Describes a novel type of crank axle on the locomotives of the Austrian State Railways. Ills. 1500 w. Glasers Ann—Feb. 1, 1910. No. 12481 D.

Locomotive Fuels.

Oil Burning on Freight Locomotives. H. B. MacFarland. A report of practical experience with liquid fuel in America. Ills. 3000 w. Cassier's Mag—March, 1910. Special No. No. 12525 D.

Locomotive Operation.

Supervision Tending to Economy in the Operation of Locomotives. J. R. Alexander. Discusses methods for obtaining efficiency in the operation of locomotives, the education for the service, examinations, fuel economy, care of tools, etc. Discussion. 17000 w. Pro Ry Club of Pittsburgh—Jan. 28, 1910. No. 12569 C.

Locomotive Power.

Tractive Effort, Power and Speed in Steam Locomotives (Ueber Zugkräfte, Leistungen und Geschwindigkeiten bei Dampflokomotiven). G. Lanz. A discussion of the relation between the three characteristics. Ills. 3600 w. Schweiz Bau—Feb. 19, 1910. No. 12477 B.

Locomotives.

Modern High-Speed Locomotives. J. F. Cole. An illustrated review of current American practice. 5500 w. Cassier's Mag —March, 1910. Special No. No. 12513 D.

Compounding and Superheating in Horwich Locomotives. George Hughes. Discusses the economy of the compound over the simple engine, and of the superheater over the non-superheater. Ills. 7000 w. Inst of Mech Engrs—March 17, 1910. No. 12727 N.

Construction and Working of Balanced Compound Locomotives in Hungary. Charles R. King. Gives data from tests made, showing the extraordinary pulling capacity with heavy train loads, at high speeds. Ills. 4000 w. Mach, Ry Ed —Jan., 1910. No. 12271 C.

Development of the Mallet Locomotive. Grafton Greenough. Explains how this locomotive differs from common types, reviewing it's development. Ills. 4000 w. Jour Fr Inst—March, 1910. No. 12749 D.

The Mallet Locomotive in Service. Editorial discussion of this machine and its operation, concluding that it is economical and satisfactory. 1300 w. Ry Age Gaz—March 11, 1910. No. 12247.

An Experimental Mallet Articulated Locomotive. G. I. Evans. Illustrated detailed description of a design for the Canadian Pacific Railway, constructed under the direction of H. H. Vaughan. 5500 w. Am Engr & R R Jour—March, 1910. Serial. 1st part. No. 12167 C.

A Locomotive with the Cab Over the Pilot. Illustrated description of a Mallet compound for the So. Pacific Ry. 400 w. Eng News—March 10, 1910. No. 12212.

Passenger and Freight Power for the Chicago Great Western. Illustrated descriptions of 4-6-0 passenger engine and 2-8-0 freight engine. 1000 w. Ry & Loc Engng—March, 1910. No. 12117 C.

British Express Locomotives. John Farquharson M'Intosh. Twenty-five illustrations of high speed passenger engines in Great Britain, with descriptive notes and information. 2000 w. Cassier's Mag—March, 1910. Special No. No. 12522 D.

Central South African Mallet Compound. Illustrated description of an engine designed for a 3 ft. 6 in. gauge. 1000 w. Ry & Loc Engng—March, 1910. No. 12113 C.

Mogul Locomotives for the Tientsin-Pukow Railway, China. Illustrated descriptions of engines for general road service, built in America. 900 w. Ry Age Gaz—March 4, 1910. No. 12125.

Some Recent Designs of Locomotives for Service on Continental Railways. Albert H. Bone. Illustrates and describes engines from German, French, Swiss, and Belgian works. 15000 w. Cassier's Mag—March, 1910. Special No. No. 12524 D.

Heavy Express Locomotives for French Mediterranean Railways. Charles R. King. Illustrates and describes the Henry and the De Glehn types. 2500 w. Mach, Ry Ed—March, 1910. No. 12274 C.

High-Speed Compound Locomotives with Three Coupled Axles and 1.9-Mètre Driving Wheels on the Royal Portuguese Railways (Les Locomotives compound à grande Vitesse à trois Essieux couplés et à Roues Motrices de 1.9 m. de la Compagnie Royale des Chemins de Fer Portugais). Henri Lavialle d'Anglards. Illustrated description and report of performance. 2000 w. Rev Gen d Chemins Fer—Feb., 1910. No. 12421 G.

Locomotive Testing.

Reading Indicator Diagrams. An explanation with typical diagram. 1000 w. Ry & Loc Engng—March, 1910. No. 12114 C.

Passenger Cars.

British Railway Coaches for South America. Illustrates and describes two special saloon coaches for exhibition at the Buenos Ayres Centenary Exhibition. 1000 w. Engr, Lond—March 18, 1910. No. 12744 A.

Composite Corridor Brake Carriage; Cambrian Railways. Illustrated description of a recent design. Plate. 700 w. Engng—March 4, 1910. No. 12289 A.

Refrigeration.

The Pre-Cooling Plant of the Southern Pacific at Roseville, Cal. Illustrated description of a plant built for the Pacific

Fruit Express Co. for precooling California fruits for shipment east. 1200 w. Ry Age Gaz—March 18, 1910. No. 12344.

Shops.

The Equipment of Railway Workshops. G. H. Burrows. Illustrates and describes workshop arrangements and machine tools. 5000 w. Cassier's Mag—March, 1910. Special No. No. 12527 D.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrated detailed description of shop practice at the Juniata shops, especially the making of main and side rods. 5000 w. Mach, Ry Ed—Feb., 1910. No. 12272 C.

Car Shops, Old and New. Discusses the change in system that has been generally effected. 1800 w. Ry Age Gaz—March 4, 1910. No. 12128.

The Empalme Shops, Southern Pacific Railroad of Mexico. Plan and illustrated description of the buildings. 2000 w. Eng Rec—March 12, 1910. No. 12244.

Sleeping Cars.

Sleeping Cars of Radically New Design for the Illinois Traction System. Illustrated detailed description of the constructional features of new sleeping cars for electric railway service, showing improvements in both arrangements and car body design. 2500 w. Elec Ry Jour—March 19, 1910. No. 12333.

Springs.

The Design of Heavy Helical Springs for Railroad Cars. Egbert R. Morrison. Gives derivation of formulae with parallel examples, showing the ease of application. Ills. 800 w. Mach, Ry Ed—Jan., 1910. No. 12270 C.

Train Lighting.

The Necessity of Introducing Electric Lighting in Railway Trains (Ueber die Notwendigkeit der Einführung der elektrischen Beleuchtung in den Eisenbahnwagen). J. Seidner. Emphasizes the safety of electric lighting and compares the cost with that of gas. Ills. 2800 w. Elektrotech u Maschinenbau—Feb. 20, 1910. No. 12623 D.

Improvements Effected in the System for Simultaneous Lighting of Gas Lamps on the Eastern Railway of France (Note sur les Perfectionnements apportés au Système d'Allumage instantané des Trains éclairés à l'Incandescence par le Gaz en Essai à la Compagnie des Chemins de Fer de l'Est). Describes in detail an electrical system. Ills. 5500 w. Rev Gen d Chemins de Fer—Feb., 1910. No. 12420 G.

Train Resistance.

New Rules for Computing Train Resistance. Abstract of a monograph issued by the American Locomotive Co., with editorial remarks. 1500 w. Eng News—March 10, 1910. No. 12221.

Wheels.

Car Wheels. George L. Fowler. On the evolution of the iron and steel wheel. Ills. 4000 w. Cassier's Mag—March, 1910. Special No. No. 12516 D.

NEW PROJECTS.

Australia.

The Trans-Continental Railway of Australia. Map and information concerning this proposed line. 2000 w. Engng—March 11, 1910. No. 12394 A.

Hudson Bay Railway.

The Hudson Bay Railway Project. Maps and discussion of the proposed line and the possible benefits, traffic probabilities and related subjects. 2000 w. Eng News—March 3. 1910. No. 12108.

The Hudson Bay Railway. Map, and information concerning the proposed line to reach Hudson Bay. Ills. 2200 w. Eng Rec—March 12, 1910. No. 12240.

Western Pacific.

Construction of the Western Pacific Ry. Illustrated detailed description of the construction of this extension of the Gould system from Salt Lake City to the Pacific Coast, at San Francisco. 7500 w. Ry & Engng Rev—March 12, 1910. No. 12263.

PERMANENT WAY AND BUILDINGS.

Bridge Inspection.

Railway Bridge Inspection and Erection. Abstract of appendices to the report of the Committee on Iron and Steel Structures, presented at meeting of the Am. Ry. Engng. & Main. of Way Assn. 2500 w. Eng News—March 24, 1910. No. 12586.

Bridges.

See under CIVIL ENGINEERING, BRIDGES.

Coaling Stations.

Railway Fuel Supply. Raffe Emerson. An illustrated discussion of fuel handling at railway coaling stations, the cost, etc. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12526 D.

Construction.

The Construction of the Ninth Division (Hills Section) of the Assam-Bengal Railway. Thomas Richard Nolan. General description of the physical features, geology, etc., with drawings and detailed description of the construction work. 10000 w. Inst of Civ Engrs, No. 3588—1909. No. 12593 N.

Stuartstown Narrow-Gauge Railway, Natal. Walter Sweetman. Illustrations and description of the construction of a 2-foot-gauge railway across the south of Natal, through exceptionally rough country. 3000 w. Inst of Civ Engrs, No. 3803—1909. No. 12594 N.

Elevated Railways.

Revision of Oak Park Elevated at Entrance to New North Western Terminal, Chicago. Explains conditions that made necessary the raising of the elevated structure, giving illustrated description of the work. 1000 w. Ry Age Gaz—March 18, 1910. No. 12346.

Grade Reduction.

Heavy Regrading by Means of Hydraulic Sluicing at Seattle, Wash. George Holmes Moore. An illustrated account of the lowering of the section known as Denny Hill. 3000 w. Eng News—March 31, 1910. No. 12774.

Narrow-Gauge.

See Construction, under PERMANENT WAY AND BUILDINGS.

Rack Railways.

Mountain and Rack Railways. Roman Abt. Illustrates and describes methods of overcoming very steep grades. 1200 w. Cassier's Mag—March, 1910. Special No. No. 12521 D.

Rails.

Investigation of Defective Open Hearth Rails. Robert Job. From a paper read before the Am. Soc. for Test. Mat. Illustrated detailed account of research work. 1200 w. Ry Age Gaz—March 11, 1910. No. 12249.

Terminals.

Unit Movements at Terminal Stations. H. McL. Harding. Discusses the handling capacity of freight stations. 3500 w. Eng Rec—March 12, 1910. No. 12245.

The New York Terminal Extension of the Pennsylvania Railroad. The Terminal Station—West. B. F. Cresson, Jr. Illustrated detailed description of the station between 31st and 33d Sts., Ninth and Tenth Aves., New York City, and its construction. 11000 w. Pro Am Soc of Civ Engrs—Feb., 1910. No. 12655 E.

Ties.

Steel and Reinforced-Concrete Sleepers in the United States. A review of the types tried and the degree of success reached. 3000 w. Engng—March 4, 1910. No. 12288 A.

Conservation of Cross-Ties by Means of Protection from Mechanical Wear. Extracts from a paper read before the Am. Ry. Engng. & Main. of Way Assn., by J. W. Kendrick. Ills. 5000 w. Ry & Engng Rev—March 19, 1910. No. 12383.

Protection of Cross-Ties from Mechanical Wear by Means of Plugs, Screw Spikes and Tie Plates with Estimates of Costs and Savings. J. W. Kendrick. Extracts from a paper read before the Am. Ry. Engng & Main. of Way Assn. 3000 w. Engng-Con—March 30, 1910. No. 12768.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Track Construction.

Track Construction in the Detroit River Tunnel. Brief illustrated description of a special type of track construction. 700 w. Eng Rec—March 5, 1910. No. 12147.

Track Maintenance.

The Economics of Railroad Maintenance of Way. W. M. Cunningham. Gives an outline of railway maintenance, with tables showing relative cost, explaining the policy of the better roads. 4000 w. Jour of Acc—March, 1910. No. 12300 C.

Transfer Bridges.

The Oak Point Float Bridges on the East River. Illustrated description of double-track suspended bridges, operated by electricity. 3000 w. Eng Rec—March 12, 1910. No. 12242.

Tunnels.

See Track Construction, under PERMANENT WAY AND BUILDINGS.

Water Supply.

See E. P. and S. Railway, under CIVIL ENGINEERING, WATER SUPPLY.

TRAFFIC.

Car Interchange.

The American Railway Clearing House. Arthur Hale. Paper prepared at the request of the Committee on Clearing House Settlements of the Soc. of Ry. Financial Officers. Explains the methods and work, giving the history of the undertaking. 3000 w. Ry Age Gaz—March 11, 1910. No. 12250.

Explosives.

Promotion of Safety in the Transportation of Explosives and Other Dangerous Articles in the United States. Col. B. W. Dunn. Describes past and present methods used on railroads, and explains the origin, organization and work of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles. Ills. 6000 w. Jour Fr Inst—March, 1910. No. 12748 D.

Freight.

See Terminals, under PERMANENT WAY AND BUILDINGS.

Freight Handling.

The Cost of Terminal Freight Handling in the Port of New York. A brief criticism of the terminal methods at this port, with suggestions for their improvement. 1000 w. Eng News—March 31, 1910. No. 12775.

Freight Rates.

The Western Freight-Rate Situation. Samuel O. Dunn. From an article in *Scribner's Mag.* 1200 w. Ry. Age Gaz—March 25, 1910. No. 12640.

MISCELLANY.

Africa.

Railway and Engineering Progress in Africa. J. Hartley Knight. A review of engineering achievements and opportunities, and the demand for power, machinery and equipment. Ills. 2500 w. Engineering Magazine—April, 1910. No. 12681 B.

Forestry.

Forestry Work of the A., T. & S. F. Ry. Illustrated description of the eucalyptus grove in southern California. 5000 w. Ry & Engng Rev—March 12, 1910. No. 12264.

France.

Transportation and Traffic in France. Logan G. McPherson. Historical review.

9000 w. Ry Age Gaz—March 11, 1910. No. 12251.

Natal.

See Construction, under PERMANENT WAY AND BUILDINGS.

Pennsylvania R. R.

Pennsylvania Railroad. Editorial review of the financial and business condition, earnings, expenses, etc. Map. 2200 w. Ry Age Gaz—March 11, 1910. No. 12248.

Taxation.

The Need of Uniform Railway Taxation. Charles Hansel. Explains present conditions in the United States and the difficulty of remedying the methods of taxation employed. 1500 w. Ry Age Gaz—March 25, 1910. No. 12641.

Transandine Railroad.

The Trans-Andine Railroad Completed. Thaddeus S. Dayton. Information concerning the new railroad over the Andes connecting Valparaiso and Buenos Aires. 1500 w. Ir Age—March 17, 1910. No. 12302.

STREET AND ELECTRIC RAILWAYS.

Car Wheels.

Cast-Iron and Steel Wheels Discussed at Hartford. Paper by F. A. Beebe, with discussion. The paper was an answer to practical questions submitted in advance. Ills. 2000 w. Elec Ry Jour—March 12, 1910. No. 12223.

Conduit Rails.

Reinforcement of Conduit Rails at Washington. Philander Betts. Illustrated description of the work with some figures regarding its cost. 1000 w. Elec Ry Jour—March 12, 1910. No. 12222.

Electric Traction.

Electric Railway Problems. J. G. Pertsch. Explains method and applications of graphical integration and differentiation in solving train movement problems. 2500 w. Sib Jour of Engng—March, 1910. Serial. 1st part. No. 12553 C.

Locomotives.

The Development and Design of the Electric Locomotive. Theodore Rich. Illustrated review of the development of electric traction on railways. 5000 w. Cassier's Mag—March, 1910. Special No. No. 12515 D.

Modern Developments in Heavy Locomotives. C. L. de Muralt. Deals especially with trunk line electrification and heavy electric locomotives. 3500 w. Jour Worcester Poly Inst—March, 1910. No. 12323 C.

The New "Pennsylvania" Locomotives. George Gibbs. Information concerning the locomotives for the N. Y. terminal extension of the Penn. R. R. Ills. 1000 w. Yale Sci M—March, 1910. No. 12647 C.

Milwaukee, Wis.

Improving the Street Railway Service at Milwaukee, Wis.; the Result of an Investigation by the Wisconsin Railroad Commission. Describes the investigation made. 3000 w. Eng News—March 24, 1910. No. 12588.

Monorail.

The Function of the Gyroscope in Monorail Cars (Die Wirkungsweise der Kreisel im Einschienenwagen). Herr Bolstorff. A discussion and criticism of the Scherl system. Ills. 3800 w. Glasers Ann—Feb. 15, 1910. No. 12484 D.

Municipal Control.

Methods of Municipal Control and Regulation of the Chicago Street Railways. Brief account of the history of the street railway franchises and systems of Chicago, with a summary of the principal provisions of the settlement ordinances. 4000 w. Eng News—March 10, 1910. No. 12213.

New York City.

Development of the New Metropolitan Street Railway. An account of the changes made during the receivership through which the lines have passed. 3500 w. Elec Ry Jour—March 26, 1910. No. 12651.

Power Conversion.

Changing an Interurban Electric Railway from Alternating to Direct-Current Operation. Explains the cause of the change and shows the general scheme of the 1200-volt d. c. system. 1500 w. Eng News—March 3, 1910. No. 12111.

Shops.

Tramway Repair Works and Machinery. C. Pendlebury. An illustrated discussion of maintenance of electric tramway equipment. 2500 w. Cassier's Mag—March, 1910. Special No. No. 12519 D.

Subways.

A New Subway Line for New York City; Its History. Reviews the history of the new triborough subway. Map. 3500 w. Eng News—March 10, 1910. No. 12218.

Kearney High-Speed Railway. Brief illustrated description of a new single-tube electric system. 1000 w. Elec Engr, Lond—March 11, 1910. No. 12386 A.

Trunk Lines.

The Economics of Electric Trunk-Line Operation (Ueber die Wirtschaftlichkeit der elektrischen Vollbahnen). Herr Frankel. A general discussion. 5500 w. Glasers Ann—Feb. 15, 1910. No. 12483 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Dusseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE. *Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Building Materials.

Introduction to the Chemistry and Physics of Building Materials. By Alan E. Munby. Size, 8 by 6 in.; pp., xx, 345. Ills. Price, $2. New York: D. Van Nostrand Company.

A general and elementary treatment of the subject, designed to enable persons without knowledge of chemical and physical science to appreciate something of the principles which underlie the use of building materials. The first part of the book deals with the principles of physics, chemistry and geology which have a direct bearing on the production, use and decay of materials. In the second part these principles are applied to the study of stones, brick clays, limes and cements, the metals, timber, and paints. The author has attempted to do little more than generalize. For detailed information he refers the reader to the standard works on the individual subjects; but within the limits of treatment he has set he has produced a useful guide to the employment and preservation of building materials.

Gas Turbines.

The Gas Turbine. By Henry Harrison Suplee. Size, 9 by 6 in.; pp., 262. Ills. Price, $3. Philadelphia: J. B. Lippincott Company.

A summary of such theoretical and practical data as are now available in the solution of the problem of the gas turbine, most of which have already been published in the transactions of societies or in technical periodicals. Introductory chapters on the early development of gas-turbine theory are followed by reprints of R. M. Neilson's paper before the Institution of Mechanical Engineers in 1904, and M. L. Sekutowicz's paper before the Société des Ingenieurs Civils de France in 1906, with the discussions they elicited. A chapter on the actual behavior of gases in nozzles describes the experiments of Dr. Charles E. Lucke, and the practical work of Armengaud and Lemale is described in detail. In a brief concluding chapter Mr. Suplee draws general conclusions as to the possibility of making the gas turbine a commercial machine.

Metallurgical Appliances.

The Mechanical Appliances of the Chemical and Metallurgical Industries. By Oskar Nagel. Size, 9 by 6 in.; pp., 307. Ills. Price, $2, 8/6. New York: Published by the Author.

A review of all the prominent types of machines which are of interest to the industrial chemist and metallurgist, with detailed descriptions of the leading representatives of each type. The first section of the book discusses the generation, transmission and utilization of steam, water, gas and electric power as employed in the chemical and metallurgical industries. This is followed by a study of methods and appliances for the transportation of solids, liquids and gases. The remaining chapters are devoted to grinding and mixing machines, firing and furnaces, separating, the purification of gases, evaporating, distilling and condensing, drying appliances, and the measurement of temperature.

Petroleum Mining.

Petroleum Mining and Oil-Field Development. By A. Beebe Thompson. Size, 9 by 6 in.; pp., xx, 362. Ills. Price, $5. New York: D. Van Nostrand Company; London: Crosby Lockwood & Son.

A guide to the exploration of petroleum lands, and a study of the engineering problems connected with the winning of petroleum. The chapter headings are: Introductory; Geological Structure and Petrographical Character of Petroleum Fields, and their Bearing upon the Distribution of Petroleum in the Strata; Indications of Petroleum and Phenomena Associated with its Occurrence; Origin, Composition, Characteristics, and Treatment of Petroleum; Systems of Drilling or Boring for Petroleum and Natural Gas; Casing or Lining Tubes for Oil Wells, and Appliances Employed in Connection with its Insertion, Extraction and Repairs; Exclusion of Water from Oil Wells; the Extraction of Petroleum and Natural Gas: Sources of Energy in Oil Fields; the Combustion of Liquid Fuel; and the Measurement, Collection, Transmission, and Utilisation of Natural Gas.

Sheet-Metal Work.

Practical Sheet and Plate Metal Work. By Evan A. Atkins. Size, 7½ by 5 in.; pp., 491. Ills. Price, $2. New York and London: Whittaker & Co.

A practical book for the sheet-metal worker, the outcome of a series of articles contributed to the *English Mechanic*. Practical methods of laying out patterns for all classes of sheet and plate work are described in detail, with a large number of very clear illustrations. Hints are given as to allowances for joints, wiring and notches, bending up, use of tools, etc. Chapters are included dealing with the surface treatment and properties of metals, mensuration rules, and sheet and plate metal working machines and tools. Besides being of distinct value to the mechanic who desires to become a more expert craftsman, the book should serve as a useful work of reference for works managers and draughtsmen.

BOOKS RECEIVED.

Rust Prevention. By L. M. Stern. Size, 8 by 5½ in.; pp., 54. Ills. Cleveland, O.: Published by the Author.

Metal Spinning. By Prof. Fred D. Crawshaw. Size, 7 by 5 in.; pp., 72. Ills. Price, 25 cents. Chicago: Popular Mehanics Co.

The A B C of Railroad Signaling. By W. H. Elliott. Size, 7 by 5 in.; pp., 75. Ills. Chicago: Mackenzie-Klink Publishing Company.

The Girl and the Motor. By Hilda Ward. Size, 7 by 5 in.; pp., 120. Ills. Price, $1. Cincinnati, O.: The Gas Engine Publishing Company.

Shaft Governors. By Hubert E. Collins. Size, 7 by 5 in.; pp., 127. Ills. Price, $1. New York and London: Hill Publishing Company.

Chaudières Marines et Accessoires. By L. Jauch and A. Masméjean. With 37 plates. Size, 10 by 6½ in.; pp., 521. Ills. Price, 22 Fr. Toulon: J. Alté.

Pumps: Troubles and Remedies. By Hubert E. Collins. Size, 7 by 5 in.; pp., 99. Ills. Price, $1. New York and London: Hill Publishing Company.

Practical Calculation of Transmission Lines. By L. W. Rosenthal. Size, 9 by 6 in.; pp., 93. Ills. Price, $2. New York: McGraw Publishing Company.

Suction Gas Plants. By C. Alfred Smith. Size, 8 by 5 in.; pp., 198. Ills. Price, $1.75. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Co.

The Portland Cement Industry from a Financial Standpoint. By Edwin C. Eckel. Size, 9 by 6 in.; pp., 93. Ills. Price, $2. New York: Moody's Magazine.

Artificial Waterways and Commercial Development. By A. Barton Hepburn. Size, 7½ by 5 in.; pp., 115. Price, $1. New York: The Macmillan Company.

Heat Energy and Fuels. By Hanns v. Jüptner. Translated by Oskar Nagel. Size, 9 by 6 in.; pp., 306. Ills. Price, $3. New York: McGraw Publishing Company.

Law and Business of Engineering and Contracting. By Charles Evan Fowler. Size, 9 x 6 in.; pp., 162. Ills. Price, $2.50. New York: McGraw Publishing Company.

Handbook for Field Geologists. By C. W. Hayes. Size, 7 by 5 in.; pp., ix, 159. Ills. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

The Temperature-Entropy Diagram. By Charles W. Berry. Size, 7½ by 5 in.; pp., xviii, 299. Ills. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

Tables for Calculating Sizes of Steam Pipes for Low-Pressure Heating. By Isaac Chaimovitsch. Size, 7 by 5 in.; pp., 47. Ills. Price, $2. Chicago: Domestic Engineering.

Smoke Prevention and Fuel Economy. By Wm. H. Booth and John B. C. Kershaw. Size, 8½ by 5½ in.; pp., 194. Ills. Price, $2.50. New York: The Norman W. Henley Publishing Co.

Hydraulic Tables. By Gardner S. Williams and Allen Hazen. Second Edition. Size, 9 by 6 in.; pp., 104. Price, $1.50, 6/6. New York: John Wiley & Sons; London: Chapman & Hall.

The Deposition of Alexander Graham Bell in the Suit brought by the United States to Annul the Bell Patents. Size, 9 by 6 in.; pp., 469. Ills. Boston: American Bell Telephone Company.

Die Herstellung von Hochprozentigem Ferrosilizium im elektrischen Ofen. By Waldemar Pick and Walter Conrad. Size, 9½ by 6½ in.; pp., 144. Ills. Price, M 6.60. Halle a. S.: Wilhelm Knapp.

Oil Motors: their Development, Construction, and Management. By G. Lieckfeld. Size, 9 by 6 in.; pp., xv, 272. Ills. 306. Price, $4.50. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Co.

The Mechanical Engineering of Steam Power Plants. By Frederic Remsen Hutton. Third Edition. Size, 9 by 6 in.; pp., xli, 825. Ills. Price, $5, 21/-. New York: John Wiley & Sons; London: Chapman & Hall.

The Theory and Practice of Bridge Construction in Timber, Iron and Steel. By Morgan W. Davies. Size, 7¼ by 5 in.; pp., 594. Ills. Price, $3.75. New York: The Macmillan Company; London: Macmillan & Co.

Lecture Notes on the Theory of Electrical Measurements. By William A. Anthony. Third Edition, revised by Albert Ball. Size, 7½ by 5 in.; pp., ix, 122. Ills. Price, $1, 4/6. New York: John Wiley & Sons; London: Chapman & Hall.

A Text Book of Mechanical Drawing and Elementary Machine Design. By John S. Reid and David Reid. Second Edition. Size, 9 by 6 in.; pp., xxi, 438. Ills., 329. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

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THE TWELVE PRINCIPLES OF EFFICIENCY

AND THE ORGANIZATION WHICH MAKES THEIR APPLICATION POSSIBLE.

*By Harrington Emerson.**

> The invisible makes the nation. The nation is not made great, it is not made rich, it is not made at all, by mines and forests and prairies and water powers. Great men make a great nation great, and the qualities that make men great are invisible.—*Lyman Abbott.*

THE owners of a large industrial plant with many orders ahead desired to increase the output from thirteen units a month, the highest average up to that time, to twenty-three units a month, and to do this in ten months.

The manager of the plant, a man of unusual ability but of the old school, had been in charge for some time, but knew only one way to deliver the increase, namely, to add to the equipment and employ more men. He therefore countered the demand of the owners for twenty-three units by asking for $500,000 worth of additional equipment. Even if this capital investment had been possible, it was no solution of the difficulty, as it would have taken at least a year, probably longer, to secure the new equipment.

When matters were in this state—demand for increased output by owners, demand for increased equipment by manager—an investigation of the plant was made by two competent efficiency engineers of wide experience, who submitted a long report of which the concluding paragraphs were:—

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* In order to obtain suitable space, our salutation and welcome to this new and great series by Mr. Emerson is placed in our Editorial Comment, immediately following the leading articles in this issue.

Your plant consists of a large
Machine Shop,
Boiler Shop,
Erecting Shop,
Blacksmith Shop,
Foundry.

Having examined into the conditions of each of the shops and having consulted with the manager, the superintendent, the various foremen, some of the contractors, and a number of men, we are able to state definitely that with some slight physical betterments, and provided the present manager, or a man of similar disposition be in authority, the output of your shops can be increased 60 per cent, without adding to the present forces, without adding to the equipment, and without increasing the payroll more than 10 per cent, and that these results can be gradually attained within a period of six months.

To accomplish these results certain principles of organization were advocated. The organization and principles were adopted and applied by the managers, and the results are shown by an extract from a letter, written by the local official ten months later.

New York, May 1, 1908.

It will interest you to know that our output for the month of April showed an increase of 69.2 per cent over the monthly average of the last fiscal year.

The average working hours are 9 per day instead of 10 as formerly. The payroll reduction is 15 per cent, amounting to $8,000 to $10,000 a month less than last year.

The same efficiency engineers were subsequently called to another plant, to investigate and to advise. In this case also their principles were accepted, their recommendations carried into effect through modified organization with the following results:

Date.	Average No. of Men.	Average Tons per man.	Total Tonnage.	Pay Roll.	Pay Roll Cost per Ton.	Increased Earnings of Men.
Sept., '08..	527	4.69	2,473	$29,380	$11.88	0 per cent
July, '09..	263	9.04	2,377	15,248	6.41	2 per cent
Aug., '09..	298	10.51	3,133	17,280	5.51	10 per cent
Sept., '09..	312	10.92	3,408	17,394	5.14	17.3 per cent

It is not to be supposed that two men could come from the far west, go into eastern industrial plants, and through their own familiarity with the conditions know better how to direct them than the experienced local managers in charge. The men who came out of the west were not as well equipped with knowledge of operation or devices, were not as well acquainted with local methods and men, as the local managers, but they were far better equipped with knowledge of a new type of organization through which alone efficiency can be secured, and they had not only this knowledge but also extended and successful experience in applying it. The difference in achievement between the modern man and the men who lived thousands of years ago is not an internal difference in quality of brain, but the tremendous external difference in conditions and equipment. The boy with the far-reaching sling knocks out the heavily armored spear-wielding giant.

It is exceedingly difficult to advocate certain principles without individuals, tribes, and nations, unable to free themselves from the personal point of view, immediately jumping to the conclusion that an attack is being made on their competency, their skill. Greek athletes could have made good records if they had had bicycles, motor cars, and aeroplanes, if they had had repeating pistols and rifles; but the arrow, however skilled the archer, does not carry as far or as straight as the rifle bullet. The principle underlying the rifle is very old—that of the blow tube—a very different principle from that of the bow and string; but the man who equips the savage with a rifle makes him more powerful than all the armored knights of chivalry, and the man who equips the modern industrial manager with a new industrial application of an old principle of organization and accomplishment, gives the mediocre manager a greater possibility of attaining high efficiency than was ever possessed even by the greatest industrial geniuses working along the old lines.*

The men from the west knew the new theories because they had applied them on a tremendous scale; they knew how to design and operate a new kind of shop control, as different from the old as the rifle is from the bow—as different as bicycle riding is from walkin, flying from motoring, Arabic notation from Roman numerals. These principles in their application to shop control may not appear particularly lofty, inspiring, or even interesting to anyone except those whose pocketbooks are to be immediately benefited—namely, the plant owners and managers, the plant workers, and the clients of the plant; but they will evoke deeper interest when it is perceived that they are fundamental and of universal application; that in all ages lasting efficiency depended on them, and without them is always impossible; that the same principles have been applied elsewhere on a stupendous and noble scale, and that it is not men or materials, money, machines, and methods that count, but far more potently theories and principles.

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* "Two kinds of success, that of the rare genius, the other, that of the ordinary man who does ordinary things a little better than his fellows." Roosevelt's university address in Norway.

We hope to arouse interest in these theories and principles and enthusiasm for them, not by sordid reference to the shop gains (although this is after all a valid ultimate test of their value) but by showing their power in recent history; and then, we can begin at the beginning and trace them up from a pre-human past into their noble work of empire building, into their not less valuable future work of industrial upbuilding.

Two of the most remarkable historical events of the last forty years are the transference of the leadership in Europe from a French Emperor to a German Emperor, the transference of leadership in the oriental North Pacific from a Chinese Emperor and a Russian Emperor to a Japanese Emperor.

As each of these startling advances was due to the same theories, organization, and principles, and as these theories, organization, and principles are equally applicable to industrial advancement, it is worth while to understand what was done and how it was done, especially as the solution of similar problems in all civilized activities is plainly the task of the Twentieth Century.

As to North and South America the Sixteenth Century was the era of discovery; the Seventeenth Century, the era of appropriation and settlement; the Eighteenth Century and the first quarter of the Nineteenth Century, the era both of making permanent what had been gained and of developing natural resources; so the Twentieth Century dawns with the as yet unaccomplished task of conservation, of eliminating wastes—wanton and wicked wastes of all kinds, wastes that make our civic governments a by-word, our destruction of natural resources a world scandal, our complacent industrial inefficiency a peculiarly national disgrace, since, of all nations, we Americans ought to know better.

It is this national inefficiency, this national wastefulness, this national squandering of current and future material, human and machine resources, that can be remedied, if we but believe and practice the plainest teachings of recent history, which are an appropriate introduction to a statement of efficiency principles and organization.

After 1850, Louis Napoleon was for twenty years the dominant figure in European politics. The British cultivated his friendship, the Italians looked to him for liberation, the Turk begged his protection, Russia was humbled by him, and Austria sought his alliance. But in the little kingdom of Prussia, about the size of Colorado, there were two men—Bismarck, the Statesman, and von Moltke the organizer, the General—who entered into a partnership to make their king the Overlord of Europe. King William had succeeded to the throne of Prussia in 1861. He was 64 years old, imbued with all the mouldy traditions of the past, but he trusted implicitly his two advisers.

Prussia was a small, poor, second-rate power comprising about one-fourth of Germany and Austria in area and population, and it was not conceded by the balance of Germany that Prussia had any right to lead. Nobody outside of Germany cared a fig for Prussia.

There was only one way to carry out the dream of the King's two advisers. There must be

(1) A definite plan, with (2) Power at each crisis to make the plan effective.

The two instruments were to be diplomacy and the army; diplomacy—to put each opponent in turn in a tight place, and then—the army, wherewith to crush him. We are not concerned with the diplomacy. It took great skill to provoke each quarrel at exactly the right moment, and war was brought on each time in the pleasant summer season. Von Moltke's task was however far more difficult. He could not count on having as many men, as much money, as abundant equipment, or as much material, as his opponents. It was evident to him that invisible theories and principles, which his self-sufficient opponents did not recognize until too late, would have to make up for meagre material resources, human lethargy, and awkward equipment.

The struggle, before it began, even in its first planning, was to be one of efficiency against inefficiency; of efficiency, applying to the army all the twelve principles, through a new conception of military organization.

Seconded by Bismarck, von Moltke advised the king to create the army, even though the people objected; and their very opposition served von Moltke, since it enabled him to carry into effect his theories and principles without meddlesome and incompetent interference.

To begin the great game, a quarrel with poor little Denmark was started. Austria, Prussia's great rival in Germany, was invited to become an ally in a war against Denmark in 1864. Two provinces, Holstein and Schleswig, were wrested from Denmark, Prussia occupying Schleswig, Austria occupying Holstein. This war gave von

Moltke a double chance. He tried out on a small scale his own organization, and studied the weakness of the Austrian organization. In 1866 Bismarck took the next step, quarreled with Austria about Holstein, and precipitated war June 14, 1866; Prussia pitted against nearly all the rest of Germany and Austria. Prussia had at that time about 22,000,000 inhabitants, Austria and the balance of Germany 59,000,000 inhabitants. From a careful study of the American civil war, von Moltke had been learning how not to do it. Bismarck gave some of the smaller German powers twelve hours to come to terms, and then almost as rapidly von Moltke's army ate them up. Two years to a day after the Battle of Gettysburg (which occurred thirty months after the firing on Fort Sumter) the Prussians, with 225,000 men, on July 3, 1866, nineteen days after the declaration of war, defeated the Austrians with 262,000 men. In three weeks more the Austrians begged for an armistice, succeeded by a peace, which transferred the leadership of Germany, held by Austria for 600 years, to Prussia. The whole plan being a business venture in empire building, Austria had to pay to Prussia 40,000,000 thaler (about $30,000,000), the smaller States paying in proportion; and, as the seat of war had from the start been in Austria, the cost of occupation fell in addition on the vanquished. Prussia annexed about 27,000 square miles. We fail to recall that any American industrial corporation ever showed for the same length of time as great gross and net earnings.

Napoleon III, Dictator, awoke too late. Bismarck and von Moltke were already preparing for the next step, the supplanting of the French Emperor by a German Emperor as the war-lord of Europe.

On July 4, 1870, the throne of Spain was offered to a German prince, Leopold. This was probably part of Bismarck's plan to provoke a quarrel. Napoleon stamped his foot once too often and for the last time. The French Emperor declared war July 19, 1870. It is said that von Moltke was asleep when the telegram came, and that when awakened, he said: "You will find the plan of campaign in the third drawer of my desk," and that he then turned over and went to sleep again. This might have been true; for, from that moment, over a million men in Germany stepped, ate, filled every minute of their time, according to pre-arranged plan and schedule. They were called from their homes and private businesses everywhere throughout the kingdoms and States; all the railroads fell in line with all their equipment. There was no confusion, no hysterics, no silly haste—"*Ohne Hast, Ohne Rast.*" The citizens called, found their uniforms and arms ready, provisions stored. Because the French plans contemplated mobilization in nineteen days, von Moltke had planned for eighteen days, knowing that this would place the seat of war in France, not in Germany. The French actually required twenty-one days to mobilize. They were of 86 per cent efficiency, von Moltke neither more nor less than 100 per cent efficient. In eleven days, 450,000 German soldiers were mobilized; on August 2, the first battle was fought; on August 6—only eighteen days after the declaration of war—one of the bloodiest battles occurred. On September 2, forty-five days after the declaration, Napoleon and his army, beaten at Sedan, surrendered and passed as prisoners into Germany.

What is marvelous is not that one great nation vanquished another, not that the victory came so soon, but that von Moltke's plans were so perfect that they were carried out to the day, in spite of the desperate resistance and antagonism of a force as strong as his own, both nations having about 40,000,000 inhabitants.

If it were not so tragically sad, it would be to laugh—to compare this war, planned by the master organizer of the last century, with our own inefficient, procrastinating, ignorantly managed and conducted civil war, dragging its weary and exhausting length through nearly four years, bequeathing a heritage of hate for forty years which it took a foreign war to assuage—bequeathing a stupendous pension burden, nine-tenths of it the money penalty for inefficiency.

In the American civil war each side was inspired by its own lofty ideal—the South by State rights, the North by hatred of human slavery; but neither side knew a single one of the twelve principles of efficiency, and so each side hopelessly floundered.

Von Moltke knew all the twelve principles of efficiency, and for him war was a serious business undertaking, not a frolic nor a fizzle; and because it was a business undertaking, Bismarck charged up every penny of its cost to France, presented the bills, and collected payment, $1,000,000,000, with interest added, besides taking two provinces (Alsace and Loraine) as a fair profit on a business venture.

It is not the pomp and glory of that campaign that appealed to me as I intimately and personally, both in Germany and in France, watched it from start to finish, for there was little of either; but the calm, merciless skill of the play showed me what principles could do when carried into effect by a suitable and competent organization. It was not the German soldiers who won the war; von Moltke would have won equally well had he applied his principles to Italian, Austrian, French, Russian, Japanese or Americans. The German recruits were not enthusiastic, and were below the European average in martial enthusiasm and spirit. It was not the German drill or tactics that won the war—mere methods, both long ago superseded. It was not the German equipment—mere devices—that won the war. The French *chassepot* was a better gun than the German *Zundnadel,* and the *mitrailleuse* was a better field piece than the Germans possessed. It was not German money that won the war, for France was at once far richer and had far better credit.

It was von Moltke's principles and organization that won; and a generation later the same organization and principles applied by a different race on the other side of the globe produced exactly the same fruit in very similar manner, under other able men.

Because von Moltke supplemented the old type of military organization, because he understood and applied all the twelve principles, the loss of life and limb in his wars was less than in great American industrial and railroad corporations, earning a similar amount, and never before in the world's history was so great a business venture carried through in better manner.

Bismarck died humiliated; von Moltke is no more; but their business teachings live, and the modern German Empire whose every activity puts Great Britain into a senseless panic is next to the greatest example the world has ever seen of the result of modern business principles applied to the development of a modern world power.

The greatest example of the power of rational organization and efficiency principles is not in the German upbuilding, but in the Japanese actual creation in a single generation of a great world power. In 1867 Japan was still feudal. The merchant guild and the thieve's guild were classed together, both beneath contempt. Her peasantry was impoverished; her finest men and women, feudal dependents without initiative. When it was still a treason punishable by death, a few of the Samurai left Japan, not for wealth or amusement or conquest of any kind, but to absorb whatever there might be good in the Western civilization and to bring it back for use in their own beloved country. They conspicuously, consistently, and intelligently put von Moltke's organization into effect in upbuilding their fatherland, and also applied all the twelve principles, which they had probably independently recognized and accepted before they began their quest. In thirty years, Japan with her 40,000,000 people was able to vanquish China with her 400,000,000. In another five years, Russia, the colossus of the North, that had shattered Napoleon I—Russia, the [illegible] of Great Britain, of France, of Germany for 90 years—went down in defeat. American sympathies were with Japan, but scarcely was the war over before the industrial organization of Japan, as much superior in principle to ours as were her army and navy to those of Russia, began to make us cry out in cowardly fear.

It is not the flesh and blood and brains of the Japanese that make them industrially dangerous; it is not their money, for they are poor, not their equipment, for they have but little, not their material resources, because they are meagre. They are dangerous as industrial competitors because we are dragging along under a type of organization that makes high efficiency impossible—and they are not; because we have not even awakened—and they have—to the fact that principles applied by mediocre men are more powerful for good than the spasmodic floundering of unusually great men.

Since life began on our planet there have always been two types of organization, types that Mr. F. W. Taylor characterizes as functional and as military. The former is an organization to build up, the latter an organization to destroy.

Primitive business was so closely allied to raids, filibustering, buccaneering, slave trading (not to omit our own American Madagascar trade) that it was inevitable that the military type should be extended to business organization the world over—a type now known to be utterly unfitted to modern business conceptions and ideals. It is von Moltke's tremendous gift to the world that, although a soldier hampered by tradition, he applied to the army the other type of organization, the functional type, which ought always to have been used in business.

Because his only chance of winning the great game he and Bismarck planned lay in superior efficiency, he was forced to study all its underlying principles, and he was equally forced to adopt the only type of organization that could apply the principles; yet so invisible was it all that even his keenest enemies saw only the familiar cocked hats, epaulettes, gold lace, and dangling swords—failed to realize that without change of name or interference with rank, even for predatory purposes, the old predatory organization had passed away and been succeeded by the functional, upbuilding, accomplishing organization.

What is all the pride of achievement of the greatest American railroad company compared to the quiet, fore-ordained plans of von Moltke in which no hitch occurred in the supreme test?

What is the greatest American corporation as a working force, compared to the perfect organization of von Moltke, the perfect organization of the small group of Japanese leaders who have made Japan a great world power?

The British, French, German and American managers of the great industrial corporations and railroads are men of great force of character, of stupendous ability, of untiring energy, devoted to the interests entrusted to them; but because they know only empirically what the principles of efficiency are, because even empirically they apply these principles only spasmodically, the plants and railroads whose well-being they are so eager to further, are operated wastefully beyond belief. The losses in American railroad operation alone run to a million dollars a day—losses preventable through the recognition, acceptance, and persistent application of efficiency principles; losses as preventable as yellow-fever deaths at Panama, or as fuel wastes if well designed engines, boilers and furnaces are used.

Efficiency, like hygiene, is a state, an ideal, not a method; but in America we have sought our salvation in methods.

American industrial organization, even when it has good methods, cannot use them, because the organization, inherited from antiquated British models, is so defective in theory as to make an application of the principles as well as of good methods impossible.

In this essay we have attempted to show that conditions of extreme inefficiency in shops as well as in empires can be converted in a very short time into states of high efficiency; that the prime instruments for efficiency in the examples cited were not men, materials, money, machines, and methods, but theories of organization and principles; that inefficiency prevails in all American activities because the type of organization is one that does not lend itself to the application of efficiency principles; that the hope of rapid improvement lies in so amending or supplementing the usual type of organization as to make it possible to apply efficiency principles.

The next essay will outline and contrast the two types of organization, and will show why one is not adapted to secure efficiency, and why the other one is.

COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION

By H. L. Gantt.

V. PRICES AND PROFITS. A NEW LIGHT ON THE COST OF LIVING.

With this chapter Mr. Gantt concludes for the present his study of "Work, Wages and Profits." This series of five articles has been, in the words of one ably qualified critic, the "cleanest-cut handling of the subject" yet presented. The topics of the several articles, beginning with that in The Engineering Magazine for February last, have been: The Compensation of Workmen; Day Work; Piece Work, and Task Work with a Bonus; Fixing Habits of Industry (a most interesting discussion of individual and shop records, illustrated by colored charts, in our May issue); and now finally, Profits.

The entire series, revised and much enlarged by the inclusion of new matter, will be republished by The Engineering Magazine in book form. The volume, under the title "Work, Wages and Profits," is now on the press.—The Editors.

INASMUCH as the chief object in manufacturing is to make profits, it seems desirable to consider more specifically the subject of profits and the effect exerted upon them by our methods.

As business increases in volume, profits will normally increase correspondingly; but there are only two ways of substantially increasing the profits on the article manufactured—one by increasing the selling price, the other by reducing the cost of production.

Inasmuch as increase of selling price yields more prompt returns, and returns that can be measured with great accuracy, much of the talent of our manufacturers has been engaged in this branch of the business. The successful salesman, or the operator who has succeeded in persuading his competitors to join with him in upholding or advancing prices, on account of the increased profits resulting from his efforts has been considered a very important man and compensated accordingly. The recognition of ability, and the compensation for success in this field, have been so great that capable workers from all directions have swarmed into it, and the industry of making prices has prospered amazingly, to the comparative neglect, often, of the production end of business.

With increase of prices comes higher cost of living; with higher cost of living comes demand for higher wages; with higher wages comes higher cost of production. Then, to maintain the same profit under the new conditions, we must again increase our selling price, and the cycle repeats itself. This process has been going on for years, and as the producers have been gradually attracted from the field of making products to the more lucrative one of making prices, we have now, in many fields, a surplus of prices and a shortage of products. This condition is today acute in the farming industry, and affects directly the cost of living.

Let us now consider the other alternative—that of reducing cost—and ask why more attention has not been paid to it, and what we may expect to get if we cultivate this field as assiduously as we have done the first.

The first cause of the small interest hitherto shown in the effort to improve production is that there is still a lingering feeling among many prominent people that the shop worker is not entitled to the same degree of consideration as the office worker; and this work cannot be done in the office. It must be done amid dirt, dust and the noise of machinery. It must be done by not only studying individually the machines that do the work; but by also studying individually the men that operate them. This is work that requires ability quite as great as, if not more greater than, that needed for the making of prices; it also requires long hours and overalls; and the compensation for success in this line does not compare with that accorded the man who adds to the bank account by getting a higher selling price.

On account of these conditions the effecting of economies in factories is usually left to the partially educated mechanic or clerk, who, whatever his success, seldom gets an adequate reward. When the compensation for success in this latter branch is made commensurate with that in the former, and then only, will it attract and hold educated men, to whom we must look for the success in any work requiring study or investigation. Study of men and processes is difficult, and we have done but little in this country to encourage it; but the time has come when we must turn our attention to it at once, for the combination of the high cost of living, and the inefficiency of production in almost all lines, is rapidly producing a condition of which no one can foresee the result.

The horizontal increase of wages being granted by so many corporations throughout the United States is not a cure, but an expedient only to enable the workmen to supply themselves for the present with a larger proportion of the necessities of life. Such a scheme provides temporary relief only, for a general increase of wages increases costs again; and, if such a policy is followed, it will not be long before a new increase of wages will be needed to meet the continually rising cost of living.

The one cure, the only one, for the condition that confronts us, is to increase the efficiency of the producer. This is not an easy problem; and there is no royal road to the desired end, for, as was said before, it means long hours and overalls, and the ability to study men and machines in the surroundings of dirt, dust and noise.

As was said before, also, this work does not attract many educated or capable men, because the compensation for success is so meager; but the time is rapidly approaching when the men that can do this work well, will be in demand at almost any price. This is peculiarly the work of the mechanical engineer, and manufacturers who realize this fact and take advantage of it will be surprised at the benefits.

It is an economic law that large profits can be permanently secured only by efficient operation; and any man, or body of men, that exacts a compensation out of proportion to the service rendered will ultimately come to grief. The supreme importance of efficiency as an economic factor was first realized by the Germans, and it is this fact that has enabled them to advance their industrial condition, which twenty years ago was a jest, to the first place in Europe, if not in the world. We naturally want to know in detail the methods they have used; and the reply is that they have recognized the value of the scientifically trained engineer as an economic factor.

In the United States, superb natural resources have enabled us to make phenomenal progress without much regard to the teachings of science, and in many cases in spite of our neglect of them. The progress of Germany warns us that we have now reached the point where we must recognize that the proper application of science to industry is of vital importance to the future prosperity of the country.

Many of our most prominent men, and men of most influence in the country, received their college training before the possibility of such a condition was even hinted at; and hence they fail to realize its seriousness. Our universities and schools of higher learning are still dominated by those whose training was largely literary or classical, and they utterly fail to realize the difference between a *classical* and an *industrial* age. This difference is not sentimental, but real; for that nation which is industrially most efficient will soon become the richest and most powerful.

If we wish to hold our place in the procession we must at once accord the scientist the place he is entitled to, and we must recognize his work, and that of the engineer, by such financial compensation as will attract our best men.

A few years ago efficiency in the United States was a local question; today it is a national question, and co-operation for its promotion will not only be of great permanent benefit to those co-operating, but will have a great educational effect on the nation at large.

Co-operation to uphold or to raise prices is seen on all sides; but it is difficult to find a single case where there has been any serious attempt at co-operation to study economies, and to inaugurate them effectively. Systematic work in this line would do more to increase prosperity, and to reduce prices, than all other influences combined; and the result might be accomplished without decreasing profits.

Moreover, if it should become the fashion to co-operate for the effecting of economies, instead of for raising prices, we should not need so much new legislation to restrain the activities of some of our most enterprising citizens.

Although the application of the scientific method to the larger problems of engineering and manufacture has been most rapid within recent years, and the great advances made testify to its success, its application to the innumerable small details of work has been largely neglected. These details have been regarded as being in the domain of trades rather than of engineering, and have been left to the mechanic. Inasmuch as mechanics, as a class, get but little benefit from the development of a better method, or a labor-saving process, they are as a rule little interested in such improvements. It is not surprising, therefore, that labor unions should offer a distinct opposition to such improvements, and that workers trained in the atmosphere of the union should consider it their duty to perpetuate this hostility. To avert this hostility we must begin by giving workmen a different training.

Before the advent of the modern factory system, each master workman owned his little shop, which he ran with the assistance of two or three journeymen; and in which he personally superintended the training of his apprentices. In training apprentices, his first object was to provide himself with capable journeymen; but he also realized that the best way to increase his reputation was to send forth men that should be a credit to him. He was therefore doubly particular that no one should leave his shop who was not able to do his work well.

With the coming of the factory system, the owner became too busy to give much personal attention to the apprentices, and as the factories grew larger, he was often unable to take from the business end enough time to make himself even, a master workman in all branches of his work. With the increasing size of the factory the superintendent also became too busy to give much personal attention to the apprentices, and they were thus left to receive their training from the foreman and their fellow-workmen, who, as a rule, have no financial interest in training additional men, who may, in time, become their competitors. This is undoubtedly the most important reason why the old apprentice system has gradually become less effective, until today it is almost obsolete. It is also a good reason why an attempt to revive it in its old form is foredoomed to failure.

The principles on which the old apprenticeship system was founded are sound—namely, that the success of the pupil should add to the reputation and financial betterment of the teacher and pupil both. It would seem, then, that if our modern methods have a similar foundation, they also will be successful. Moreover, if the training is based on the results of scientific investigation, and the methods employed are those which embody our best knowledge on the subject of teaching, we should be able, not only to provide ourselves with an abundance of skilled workmen who are capable of doing well the tasks set them, but to develop many who are able to advance the mechanic arts in a manner superior to that which gave the New England master workman of a generation ago such a wide reputation.

There is really no sharp line between mechanical engineering and trades. Wherever there is a problem to be solved, no matter how small or common-place, there is work for the educated man; and his solution by the scientific method is, as a rule, so much better than that of the mechanic without scientific knowledge, that workmen trained in the light of such a solution are far more efficient than those trained by mechanics in their methods. The increased efficiency of such men entitles them to increased compensation; and, by awarding that compensation in a proper manner, I have never failed to secure the hearty co-operation of the good men. *A system of management based on these methods is just as much a part of our assets as plant, or equipment.*

We are all familiar with plants that were failures under one manager and successes under another, or *vice versa;* but so far no satisfactory method is generally known by which a system of management can be put into such a shape as to be self-perpetuating. This is exactly what the methods described in preceding articles do accomplish, at least to a large extent. The importance of this fact is second only to that of one other, namely, that they do actually get the highest possible efficiency.

The reason our methods are permanent is that it is to the financial interest of both workman and foreman to maintain them. All other systems are maintained in their efficiency by the higher officers, and hence are liable to deteriorate when such officers become old, or are replaced. The system I have described not only makes for the highest efficiency, but is practically self-perpetuating, for the training the men receive fits each to fill a higher position.

In considering in detail the elements that affect costs of manufacture and through them, profits, most people place them in three classes:—

Wages,
Materials,
Overhead expense.

In the third class they include all the various items of expense that cannot be charged up directly to manufacturing, such as rent, taxes, insurance, salaries, selling expenses, depreciation, power, light, heat, etc. These items taken together, often amount to more than the wages paid for doing the work. This class of expense is very important, for it goes on with but little change day after day whether we do much work or little, and must be added to the cost of the output, month by month. If the output is small, this burden of expense per unit of output is large; on the other hand, if the output is large this expense per unit is correspondingly less.

Andrew Carnegie was one of the first men to appreciate to what extent this was a fact, and by making good use of it, he laid the foundation for the practical control of the steel industry.

If the output of a plant is doubled, the overhead expense per unit of product is very nearly cut in half. If at the same time we reduce the wage cost 40 per cent and double production, as we have shown can so often be done, the profits mount at a very rapid rate.

In order to illustrate these points, let us assume a hypothetical case in which we are making a profit of 10 per cent on the cost of our products, our expenses for one week being divided as assumed in the following table, which is closely in accord with probabilities:—

Material	$3,000
Wages	1,000
Expense Burden	1,000
	$5,000
Selling Price	5,500
Profit	$ 500—10 per cent of cost

Suppose now we wish to double our product. The usual method is to double the size of the plant without increasing the efficiency of operation. In this case all expenses will be doubled, except the expense burden, which will be very nearly doubled, and our case may be approximately represented by the following figures:—

Material	$6,000
Wages	2,000
Expense Burden	1,800
	$9,800
Selling Price	11,000
Profit.......	$1,200—12 per cent of cost

Suppose, on the other hand, we double our product by increasing the efficiency of operation, as we have shown can often be done, without increasing the size of the plant or the number of workmen. The following figures will be fairly representative:—

Material	$6,000
Wages	1,400
Expense Burden	1,200
	$8,600
Selling Price	11,000
Profit.......	$2,400—28 per cent of cost

The profit is nearly five times as great as in the first case, and twice as great as in the second. In the second case we have twice as much money invested in the plant as in the first and third cases. *But in the third case, where we have increased efficiency and reduced costs, the profit on invested capital is nearly five times that in either of the first two cases.*

While these figures are hypothetical, and are not applicable to all industries, they are conservative, as they represent a decrease in total cost of only 14 per cent, as may be seen by comparing $5,000, the cost in the first case, with $8,600, the cost of double the products in the last case. To get a similar increase of profit by increasing the selling price without enlarging the plant or increasing efficiency, we should have been obliged to sell goods that cost us $5,000 for $7,400, or at a profit of nearly 50 per cent. Such an increase in selling price would simply be an invitation to other competitors to come into the field. If such a competitor should operate as efficiently as we have assumed to be possible in our third case, and competition should force the price down, he could sell his goods for less than our original cost and still make a profit of 15 per cent.

If manufacturers in general realized how much an increase in efficient operation really meant to them, they would be very slow to increase the size of a plant until they had become pretty well convinced that they had gotten it up to its maximum efficiency.

What has been said of the manufacturer is true of that greatest of producers, the farmer, as well; but we must not expect him to understand what the more favored manufacturer so often fails to appreciate, namely, that efficient operation of a small plant, or farm, is more profitable than the slack operation of a large one.

If the same intelligence and industry had been applied generally to the art of production as has been exercised in selling products, I can hardly help feeling that we should be suffering less acutely today from high prices. In the long run prices are governed by supply and demand. When it comes to be generally realized that efficient production and a large, cheap, product form a more stable basis for profits than a small, expensive one, because they form a more stable basis for prosperity, we may hope that some of the talent that has been exploiting the overworked field of making prices will return to the comparatively fallow field of making products.

I do not wish to be understood as intimating that nothing has been done in this field. Much has been done, especially in the steel industry; but it is a mere drop in the bucket, when compared with what still remains to be done in almost all productive industries. The steel industry was one of the first to utilize educated engineers, and to study the methods of efficient operation. The fact that steel products brought high prices has never stood in the way of reducing cost; and today, thanks to this policy, American steel makers can compete with any in the world.

If the much boasted superiority of the American people is really a fact, and the phenomenal progress of the past is really due to the ability of the people of the United States and not mainly to splendid natural resources, we should rise to the occasion, and become the example for others to point to. This cannot be done by making prices; and a tariff that is so high as to enable profits to be made regardless of cost is not a protection, but a decided detriment to the country. A tariff that encourages efficiency is more to be desired than that which will enable its beneficiaries to accumulate wealth, *for any prosperity not based on efficiency is on an unstable foundation.*

In order to bring the efficiency of operation up to the point we have shown to be possible, we must first have absolute control of the materials we use and the tools we work with. In other words, we must see that the proper materials are always ready, and that proper tools for doing the work are available. This is a function of the management, and not of the workmen, and necessitates the keeping of an exact record of the materials used. Inasmuch as material represents money, any attempt to keep an exact record of it, and of where and how waste occurs, results at once in a saving far in excess of the cost of keeping the records.

When therefore we begin to install a system of management on the lines indicated, nearly every step produces a saving; but as many concerns have no records that show losses of material and leaks, it is usually difficult to show what has been saved by stopping such losses. Again, when we begin to put machinery in condition to enable us to run it at its proper efficiency, and to enable each man to do a proper day's work, the expense incurred to accomplish this end is usually charged against the "new system," whereas *it should be charged against the system that put the machinery out of condition.*

Inasmuch as in any change in management the mechanism of the old system must not be disturbed until that of the new system is working smoothly, there is always some time when we must practically run two systems. From these considerations it is evident, that no matter how much we may be able to increase the profits in the long run, we must not expect results to show in the form of profits at once.

The total cost of making the change from the old system to the new is not greatly different, whether it be done quickly or slowly. If it is done quickly, the benefits are gotten that much sooner; but the expense is concentrated in a short time, and unless this fact is realized from the start, it is apt to cause a certain amount of hesitation at the very time when the work should be pushed fastest. If the plant is a large one, or one doing a large variety of work, the advantages of controlling the material, planning the work, and increasing the efficiency of the individual, are so great that a little done in this direction soon makes itself felt, for the plant begins to run more smoothly, wastes diminish, and profits begin to increase, and we are on the road to our ideal, *a self-perpetuating system of management based on the efficient utilization of scientific knowledge.*

Such a system seems Utopian. Perhaps it is, but we have seen the possibilities of it so clearly, and have in actual operation approximations to it so close, that we are prepared to see its realization in the near future. Under such a system in its best development we have co-operation like that in a foot-ball team, or an orchestra, where each man has assigned to him the part he can do best, and where he does it with pride and joy to the best of his ability. The organization of such a system must be perfected by men familiar with industries and trained in the methods of scientific investigation. The graduates of our engineering schools are the men on whose shoulders this problem naturally falls, and if they are capable of handling it, they will gain for the profession of engineering the recognition to which it is already entitled, as the most important factor in modern civilization.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

III. TURBINES, WATER WHEELS, AND MECHANICAL EQUIPMENT OF THE POWER PLANT.

Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. He now takes up water-wheels and the mechanical equipment of the power station. In July he will consider the electrical machinery, and in August the transmission and distribution of current. The whole discussion is addressed not to the specialist in hydroelectric engineering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commercial associates.—THE EDITORS.

POWER plants are classified according to the available head, into low-head, medium-head, and high-head plants; the first being up to 30 feet, the second from 30 to 200 feet, and the last named (high-head) above 200 feet. This classification, however, is not closely adhered to, as many manufacturers and plant designers are ignorant of the fact that a low-head turbine is less efficient when applied to a high-head, and *vice versa.*

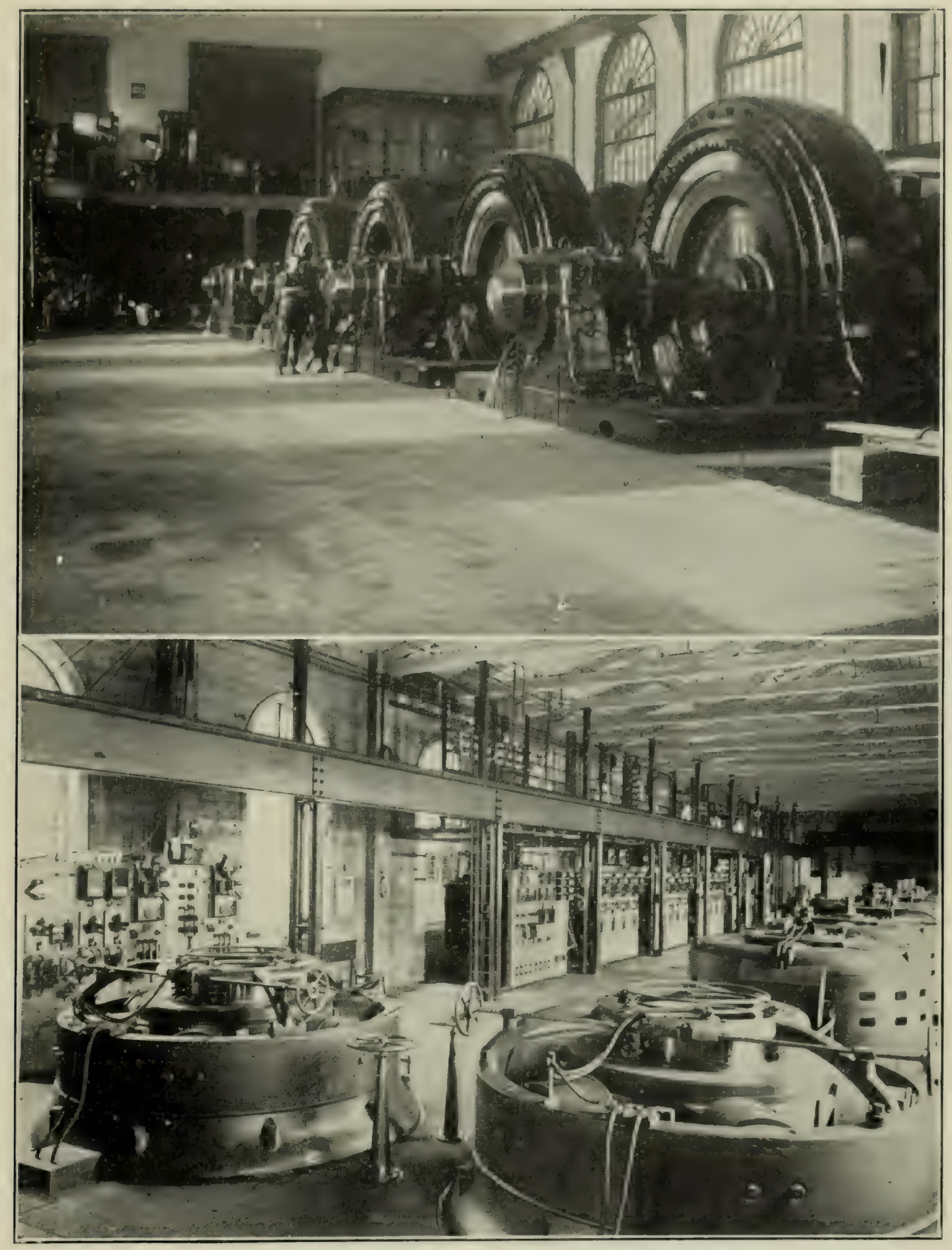
Reputable manufacturers with competent engineering staffs will advise the use of a turbine best suited for the condition at hand. Slight variations of the above classification, of course, may be made when other conditions favor them.

A rigid classification is adopted by European engineers as follows: low-head turbine, up to about 10-feet head, employing open flumes, vertical turbine shafts with bevel gearing; or, when turbines are located above ground water, horizontal shaft with belt or rope drive.

First intermediate-head turbine, from 10 to 30-feet head, in which case open flumes may be used, and vertical, or when advisable, horizontal shafts.

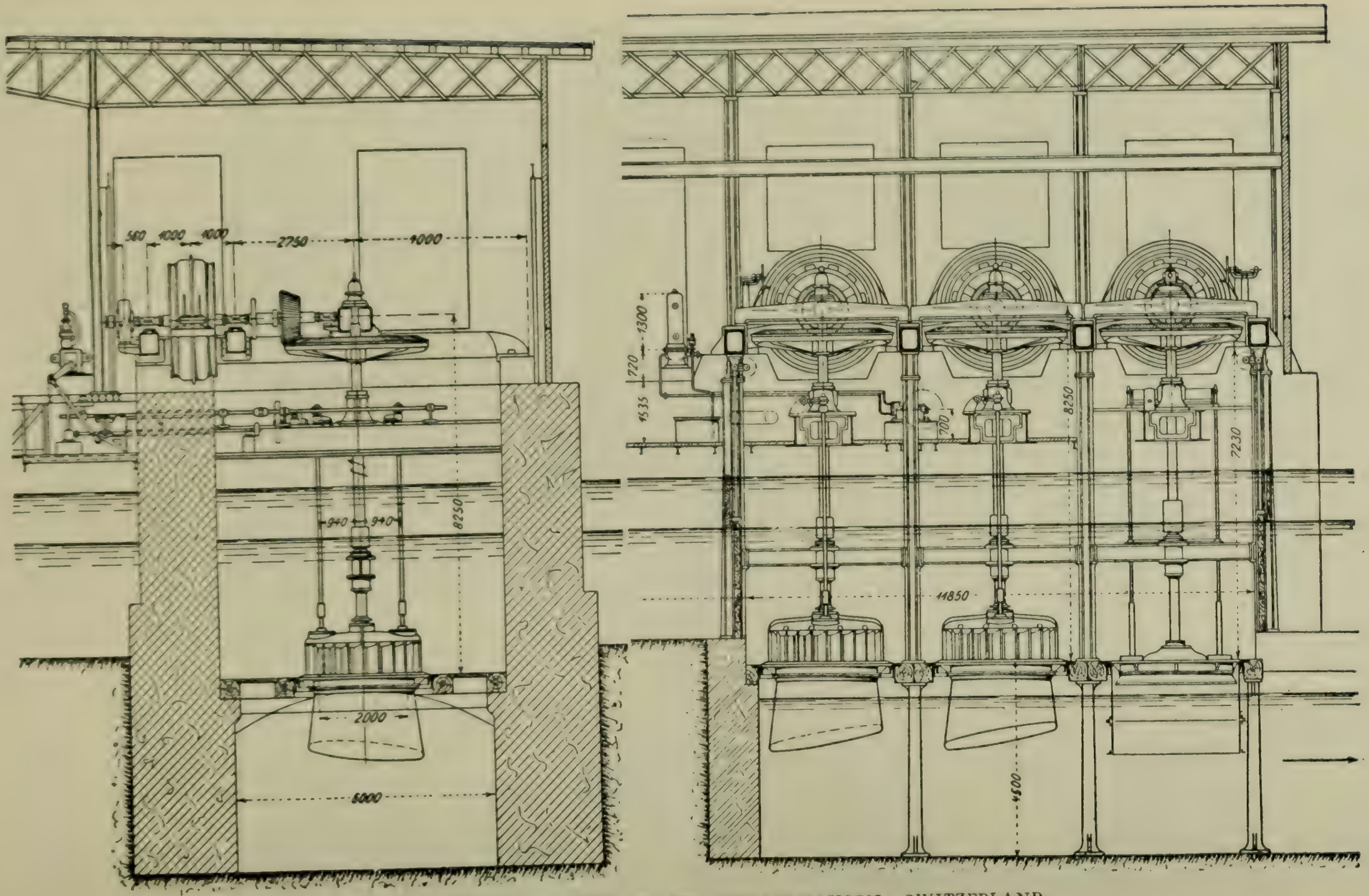
Second intermediate-head turbines, for heads from 30 to 165 feet. Closed penstocks, spiral casing, horizontal shaft. For special conditions vertical shafts may be used.

High-head turbines, above 165-feet head. Closed penstocks, spiral casing; horizontal shafts, so long as reaction wheels are used; otherwise impulse wheels with vertical or horizontal shafts.



AMERICAN HYDROELECTRIC POWER PLANTS. ABOVE, HAUSERLAKE. BELOW, OREGON CITY STATION B, PORTLAND RAILWAY, LIGHT & POWER CO.

Whatever class of turbines is chosen, care should be exercised to locate the turbines so as to secure the highest possible head. Many turbines are dependent upon draft tubes to give additional head. Whatever turbine and arrangement is decided upon, the flow of

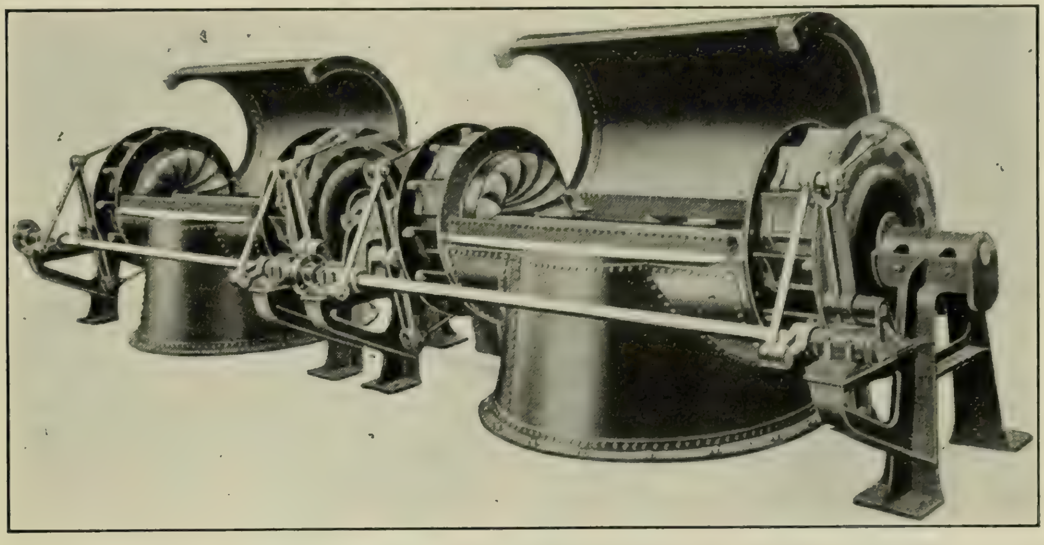


TYPICAL LOW-HEAD POWER PLANT, SCHAFFHAUSEN, SWITZERLAND.

water to and from the turbines should be as free and easy as possible, to avoid friction.

In low and medium-head plants the power house frequently forms a part of the dam, or adjoins the dam on the down-stream side; or, in case of a hollow concrete dam, it is located in the body of the dam; in such case the walls must be made waterproof to prevent seepage into the power house.

Forebays are used in connection with low-head plants, and must be located and arranged so as to deflect all foreign material as much as possible. This may be done in a similar way to that which has been discussed under the chapter on collecting basins such as are used in connection with medium and high-head plants. They must also be provided with screens, spillway, ice-run, and sand trap.



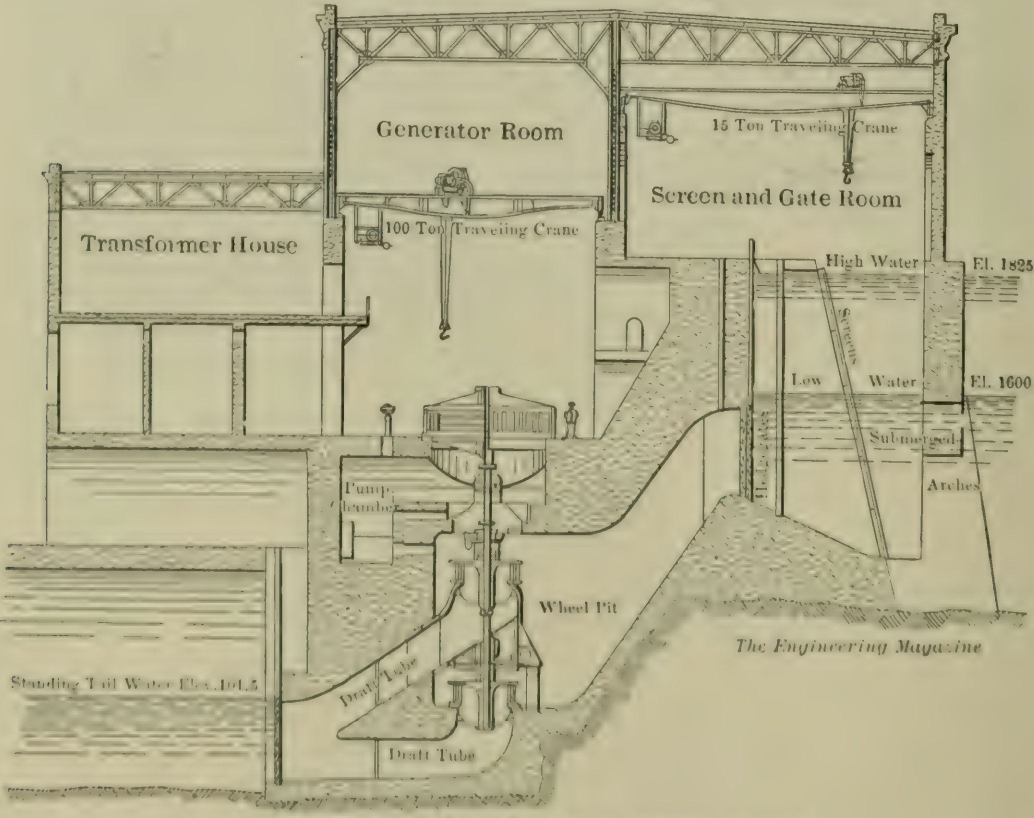
AMERICAN TURBINE AS DESIGNED BY THE DAYTON GLOBE IRON WORKS.

Low-head turbines are usually located in open flumes, and when they are provided with vertical shafts, frequently several turbines are connected by gearing to a horizontal shaft driving a generator. With this arrangement special precaution must be taken to prevent seepage or moisture from entering the generating room.

When the generators are of small size a single turbine may be geared to the generator, as will be seen in the accompanying cross section of the Schaffhausen, Switzerland, power plant, which is a typical low-head installation.

Medium-head plants are usually equipped with Francis turbines with horizontal or vertical shaft. Both arrangements have often two runners mounted upon one shaft.

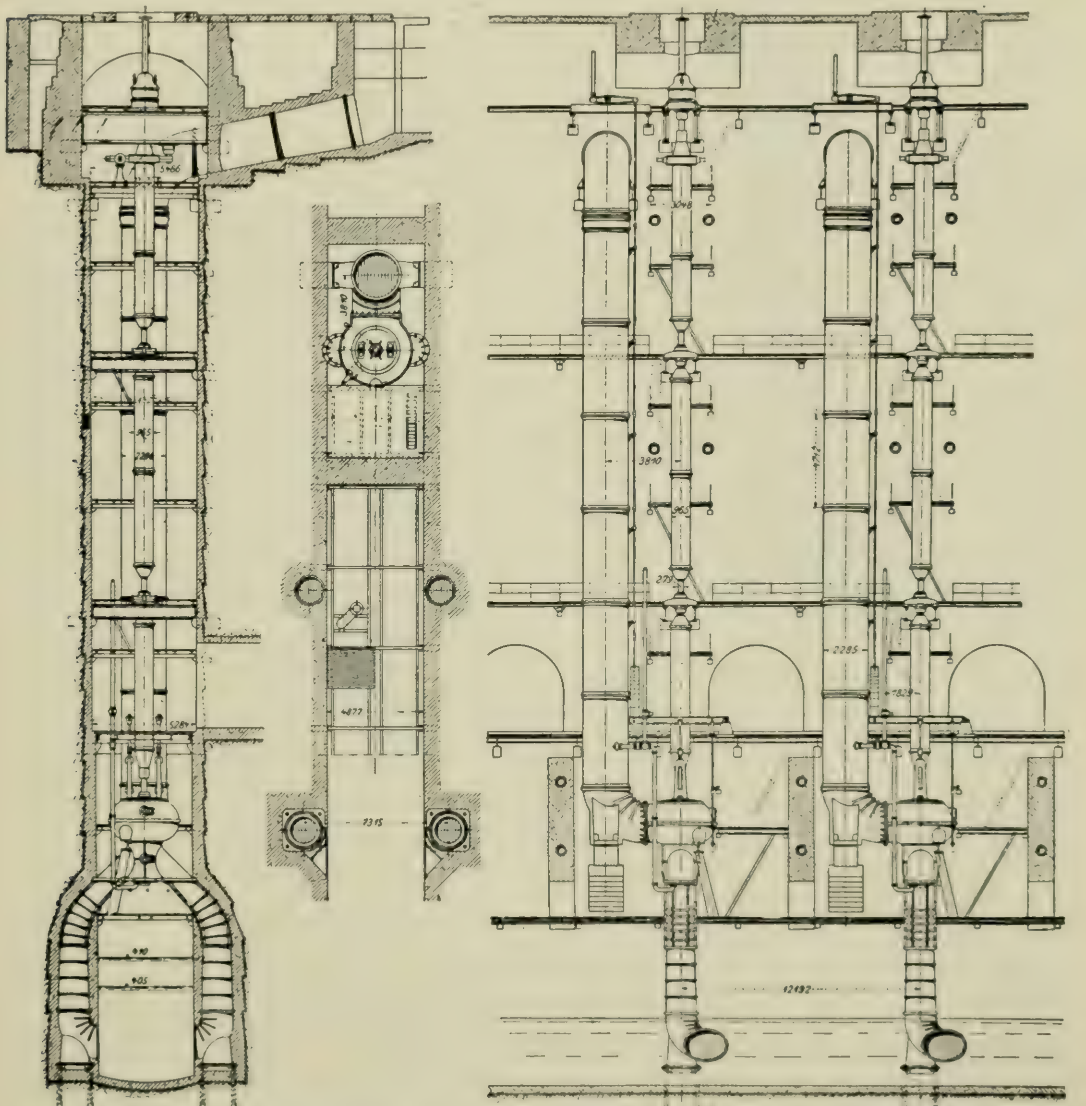
Page 344 shows the general arrangement of the McCall's Ferry Power Company's plant on the Susquehanna river. The turbines are of the inward-flow Francis type, mounted in pairs on a single shaft; when operating under a normal head of 53 feet and a speed of 94 revolutions, with a gate opening of 80 per cent, they are capable of developing 13,500 horse power. This plant, when completed, will have a normal capacity of 100,000 horse power, half of which is at present being installed. Considering the general arrangement of this plant, it will be noticed that screens and headgates are arranged in a common building adjoining the generator room and provided with a 15-ton traveling crane to facilitate handling the screens. The generator room, on account of the exceptionally large size generators, is provided with a 100-ton traveling crane. Much space is left between traveling crane and roof truss; this is presumably done for architectural reasons, upon which much stress has been laid, contrary to usual American practice. At the down-stream side of the power house and above the tailrace outlets, is a well arranged switch and transformer house.



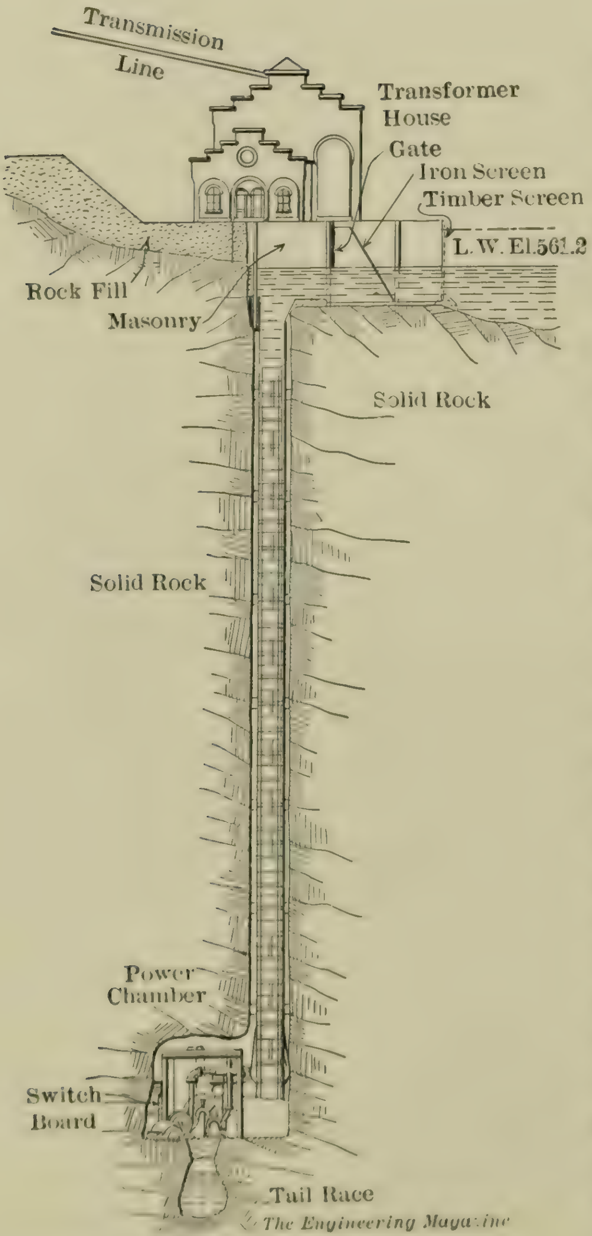
CROSS SECTION, M'CALL'S FERRY POWER HOUSE.

The Niagara Falls plants are also medium-head plants, but are of entirely different design from that of the McCall's Ferry Power Company. Four of these plants have the vertical-shaft turbine located in a pit; the arrangements vary somewhat, especially in the tail-race end. Power House No. 1 of the Niagara Falls Power Company, equipped in 1895 with 5,000 horse power units, had no draft tubes; in the latter installations, both on the American and Canadian sides, the turbines are equipped with draft tubes of different design. By omitting the draft tubes in the first plant, 700 horse power was lost for each of the ten units.

High-head power plants usually have a simple arrangement of turbines, but, on the other hand, they have a more complicated arrangement of penstock and regulating devices. It is but natural that high-head plants are located away from the center of current distribution, therefore a large electrical equipment is necessary with this type of plant. As the ground is cheap in such localities it would be an unwise policy to crowd the generating room; ample space must be allowed, particularly for the regulating devices.



ARRANGEMENT OF TURBINES, PLANT NO. 2, NIAGARA FALLS POWER COMPANY.



CROSS SECTION, SNOQUALMIE PLANT.

One of the most prominent high-head plants in America is the Kern River Plant No. 1 of the Edison Company, Los Angeles, Cal., though the capacity is not so great as others. The plant contains four 5,000-kilowatt units, each unit consisting of two impulse wheels of 9 feet 8 inches diameter; they are overhung on the shaft of the generator which is located between the two wheels. To harness the water of the river Kern, a dam 203 feet long, 20 feet above the normal river level, was constructed. The water is conducted through nineteen tunnels, aggregating a length of 42,910 feet; then through timber flumes 1,520 feet long; these are followed by reinforced-concrete conduits 503 feet long, which join the collecting basin. From here a penstock of 1,697 feet in length leads to the power house. The penstock, contrary to usual practice, leads through a tunnel, and is surrounded by concrete; it has an internal diameter of 7.5 feet, while near the power house it has a diameter of 5.25 feet.

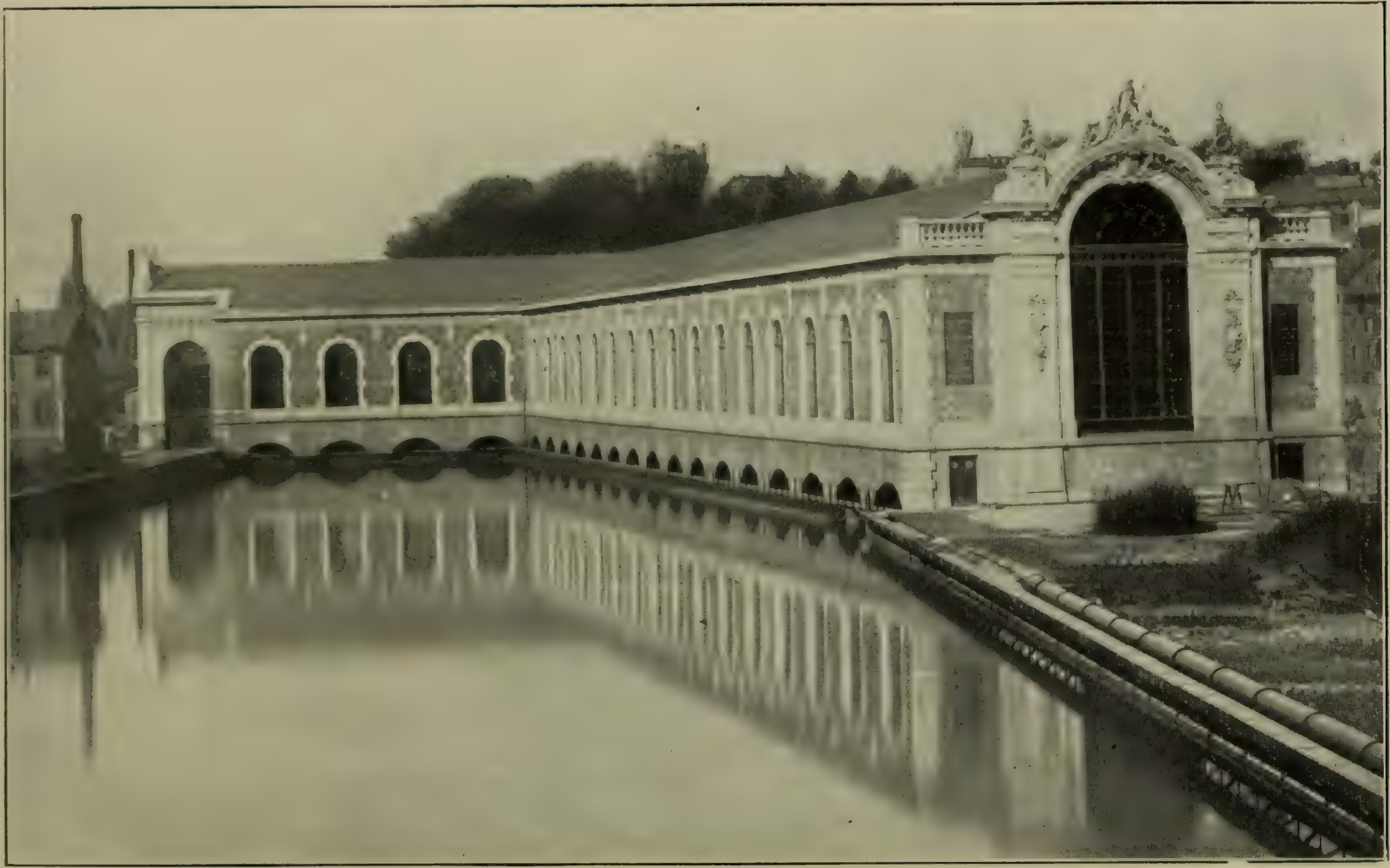
A unique arrangement of a high-head power plant layout is that of the Snoqualmie Falls and White River Power Company, Washington. A shaft of rectangular section, 27 by 10 feet, was sunk in the river bed about 300 feet above the Snoqualmie Falls. This shaft reached a depth of 270 feet, or the level of the river below the falls, and was connected with a tunnel 24 feet high and 12 feet wide, which is used as tail-race. The underground power station begins at the bottom of this shaft; it is 30 feet high, 40 feet wide, and 200 feet long. The penstock leading through the above mentioned shaft is 7.5 feet in diameter, and is connected, in the power house, to a horizontal distributing chamber of 10 feet diameter, from which impulse wheels are fed.

There are two additional shafts leading from the underground station to the distributing station at the banks of the river, one being utilized for the generator cables, the other for an elevator. Natural draft is established by the flow of water in the tail-race, causing good ventilation in shaft and generating room, which is perfectly dry and has a constant temperature of 55 degrees F.

In selecting a site for the power house the character of the soil must be given careful consideration; this may mean the shifting of the power house to a location other than originally determined upon. It is necessary that test holes be driven to ascertain the bearing power of the soil, and, if this is soft, it might be necessary to remove some of the upper layer and refill with better material thoroughly tamped. In such instance it is advisable to have one monolithic concrete mat covering the whole area of the power house. Where rock is encountered the bed of the excavation must be cleared of sand and loose boulders to give a proper bearing surface for the foundations. Piling is often necessary, and it has been the practice of late years to use concrete piling of various types.

The foundations are usually made of concrete: 1:2½:5 mixture for the smaller foundations, and 1:3:6 for larger foundations. Where exceptionally heavy foundations are necessary rubble concrete may be used in the interest of economy. Provision must be made for grouting, varying from one to two inches allowance according to the size of machinery to be set thereon.

Within the past few years rapid progress has been made in the design of hydroelectric plants, but, with few notable exceptions, nothing has been done as to the architectural features of the buildings for housing the machinery. Necessity requires only a building sufficiently strong to support and to shelter the machinery. The ultimate aim in the design of a hydroelectric plant is to generate electricity on a commercial basis. As a rule, these plants are located some distance from the centers of population, consequently the architectural features have been grossly neglected in the design of power plants, especially in America and Great Britain. This is quite the opposite to the practice on the Continent of Europe, where the consideration given to the architectural features of many plants is, from

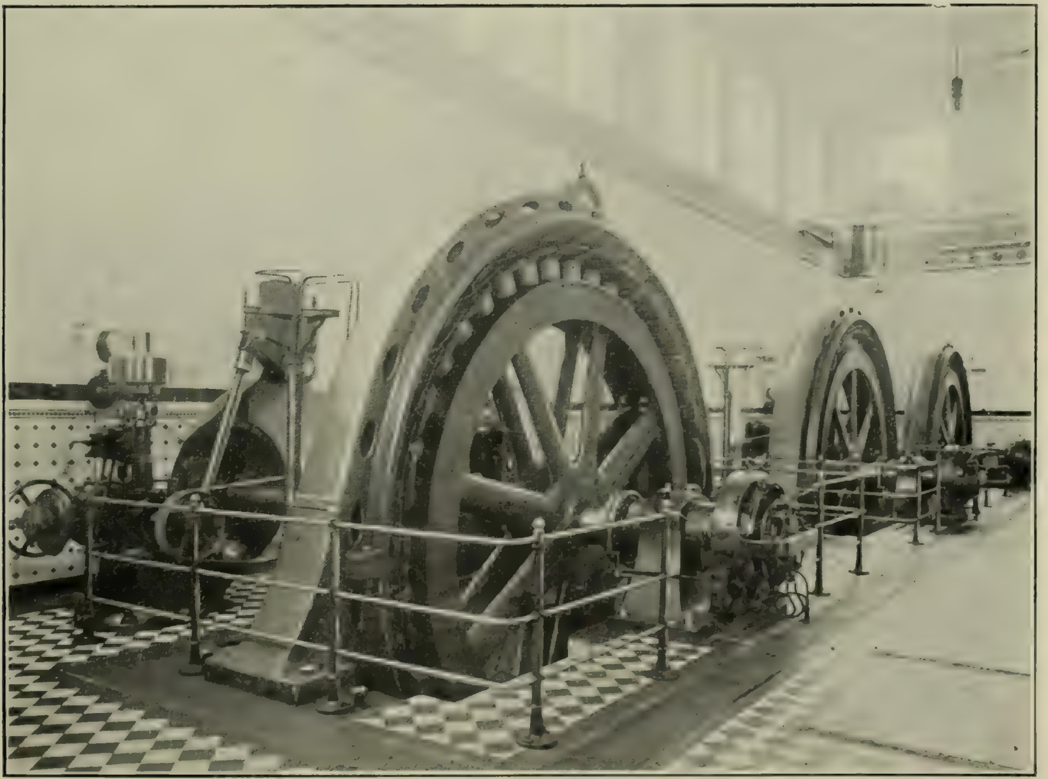


THE MUNICIPAL HYDROELECTRIC STATION, GENEVA, SWITZERLAND.

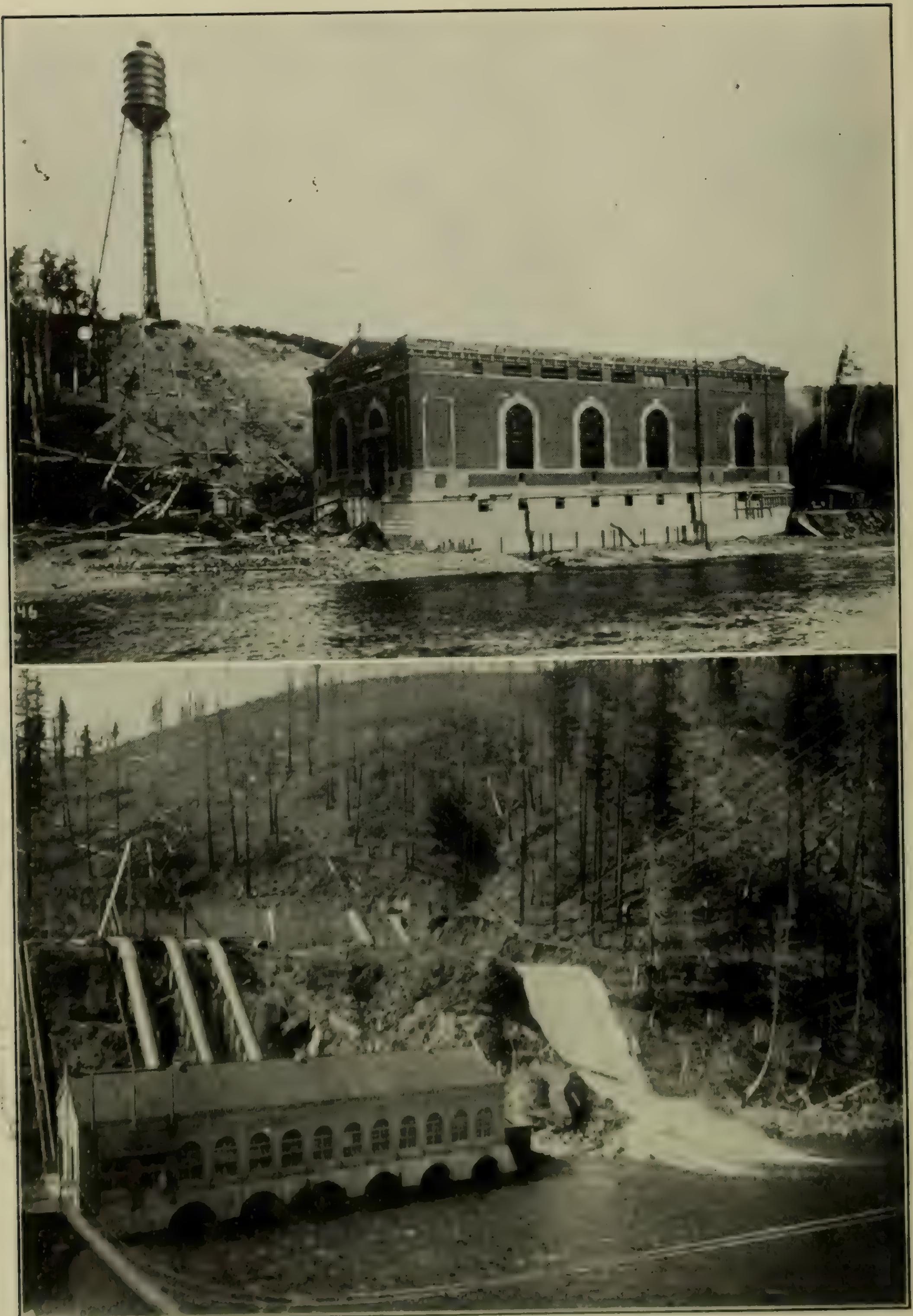
the American point of view, considered most exaggerated. From the Continental point of view, the architectural features of power plants are considered quite as important as those of private or municipal buildings. The same statement applies to the sanitary arrangements. It must not be lost sight of that a plant well designed as regards architectural features and sanitary provision will improve the *morale* of the operating force, and result also in a higher efficiency of the plant as a whole.

Some of the accompanying illustrations show what has been done in this direction on the Continent of Europe; comments are hardly necessary; they speak for themselves.

Many engineers as well as the general public have a biassed opinion as to the destruction of the scenery of the surrounding country by the erection of a power plant. This is an erroneous conception, as it may be seen from the illustrations that the beauty of the scenery of the surroundings of a power plant may be greatly enhanced. It merely resolves itself into a question of ability on the part of the designers to design a plant which will harmonize with the surrounding country, and it should be remembered, furthermore, that a pleasing appearance can nearly always be secured without adding to expense



INTERIOR OF UPPENBORN PLANT, MUNICH, GERMANY. TURBINES OF 1887 HORSE POWER UNDER A HEAD OF 26 FEET.



TYPICAL AMERICAN HYDROELECTRIC PLANTS.
Above, the Great Northern Power Co., Duluth. Below, the Cazadero Power House, Oregon.

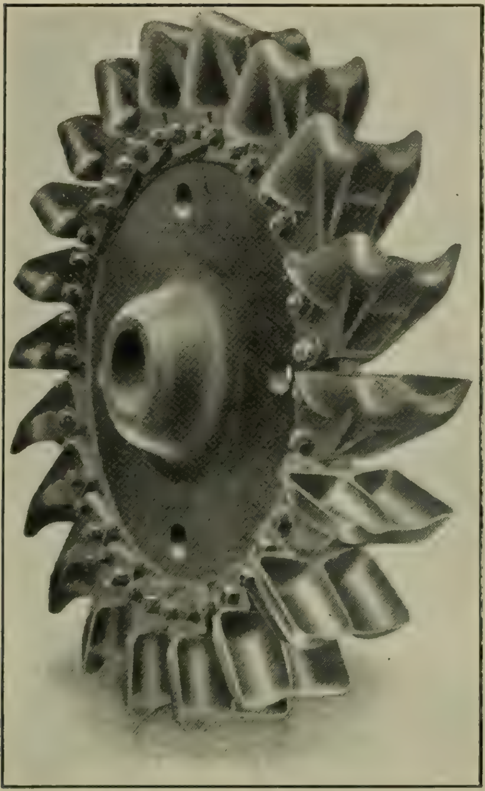
of the undertaking. In fact, many prominent plants which are masterpieces of ugliness have cost much more per unit capacity than others which are noted for their fine appearance.

The superstructure should preferably be made fireproof, and particularly does this apply to the buildings containing the electrical equipment. Proper provision must also be made for heating and ventilation and, as pertains to the latter, louvres should not be located in the roof above the generators, as many types of louvres are liable to leak upon the generators or other parts of the electrical equipment, causing short circuits which might consequently result in serious interruptions of the service of the entire system. The same is true as to windows in the switching room, which must be fixed or provided with locking devices so that they cannot be opened. Experience has shown that many breakdowns have occurred from the sudden arising of storms and lack of time, or neglect on the part of operators, to close the windows.

INTERIOR OF SILL PLANT, INNSBRUCK, TYROL, EQUIPPED WITH 2,500 HORSE-POWER IMPULSE WHEELS.

MECHANICAL EQUIPMENT.

Turbines are divided into two general types—reaction and impulse—depending upon the action of the water. In the former the flow of water must be continuous throughout all parts of the turbine;



RUNNER OF A 5,000 HORSE-POWER PELTON WHEEL.

that is to say, the runner must be entirely submerged. In the impulse type the water impinges on parts of the wheel and in nearly all cases the atmospheric air has free access to the remainder of the runner.

Turbines may be further divided, as regards their construction, into radial flow, axial or parallel flow, and combined or mixed flow. In the radial type the water passes through the wheel, either inward or outward, at right angles to the axis of rotation. In the axial turbine the general direction of the water is parallel to the axis of rotation. In the mixed-flow turbine the water enters radially and discharges axially, or *vice versa*. The different forms of reaction turbines are commonly known by the names of their inventors, as the Fourneyron, which is a radial outward flow; the Francis, a radial inward flow; and the Jonval, a parallel flow. A combination of the Jonval and Francis is known as the "American" type and is today the most common type in use in America where it originated.

Of the impulse type the Girard and the Zuppinger in Europe, and the Pelton in America, are the most familiar types. It might be of interest to state, as to the origin of the impulse wheel, that according to Professor Escher *(Zeitschrift des Vereines deutscher Ingenieure*, Feb. 18, 1905) Zuppinger installed the first tangential wheel at Weiler's Mills, near Frederichs Hafen on Lake Constance in 1846. This same engineer, according to L. Zodel *(Schweizerische Bauzeitung*, June 13, 1908) built for the Haemmerle Cotton Mills in Dornbirn, Germany, a tangential wheel in 1868-69 of 220 horse power, making 300 revolutions per minute under a head of 550 feet. This wheel was 5 feet in diameter, 30 inches wide, mounted upon a vertical shaft, and was provided with two diametrically opposite jets or nozzles. The highest efficiency of this wheel was 75 per cent.

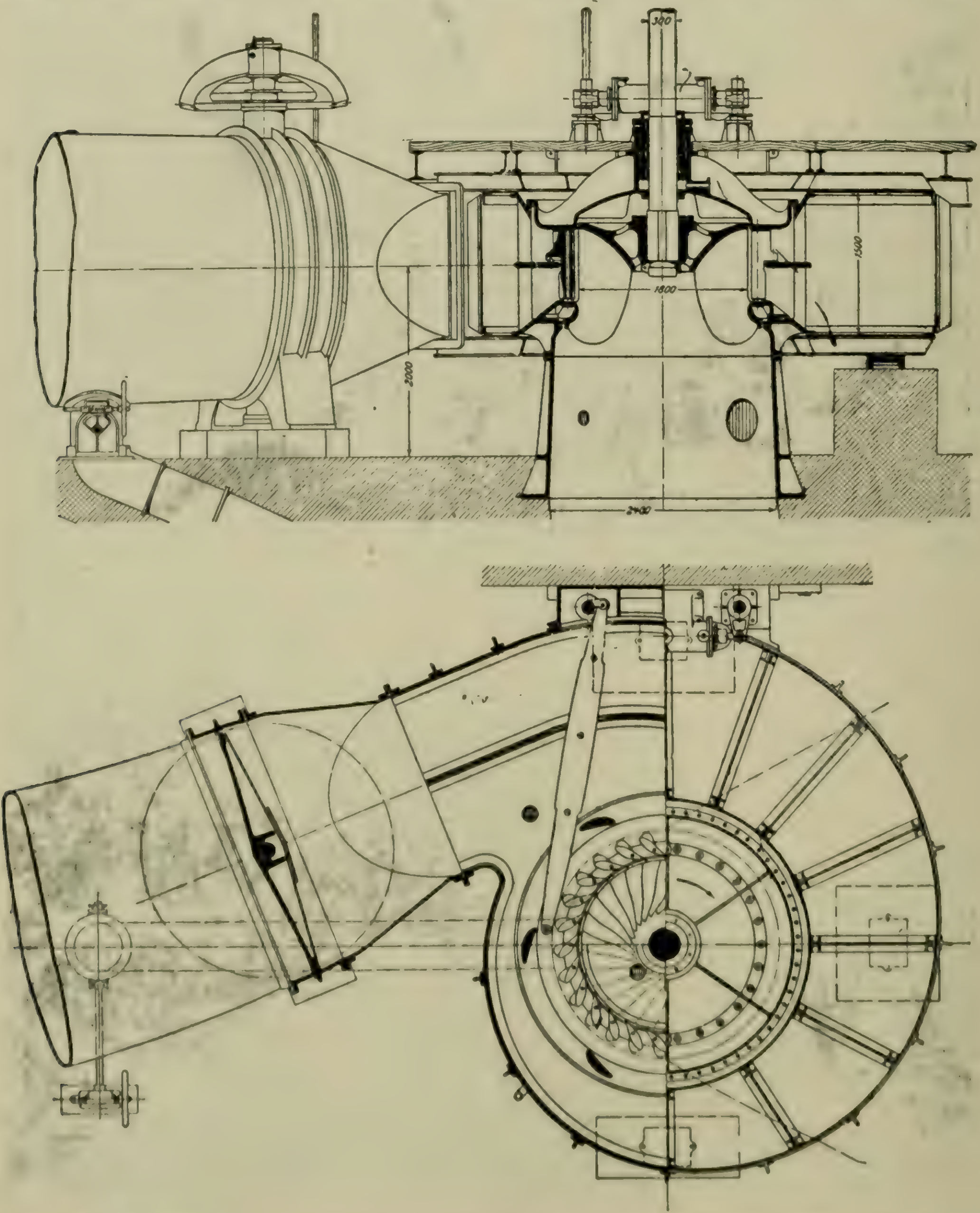
The low-head turbines, which include the American turbine, are of the horizontal and vertical types and frequently a number of runners are mounted upon a single shaft. They are sometimes placed in casings and at other times in open flumes.

Under medium-head turbines will be found a great variation of types, including high- and low-head, which is due to the fact, as previously stated, that the line of demarcation between low and medium,

A CONTINENTAL HYDROELECTRIC POWER STATION. INTERIOR AND EXTERIOR OF THE OBERMATT PLANT, LUCERNE, SWITZERLAND.

and medium and high head, is not distinctly drawn. However, the majority of the medium-head turbines are of the Francis type, which are either of horizontal or vertical pattern with one or more runners mounted upon a single shaft. They are placed either in an open chamber of the power house or in a closed chamber or casing made of cast-iron or steel plates.

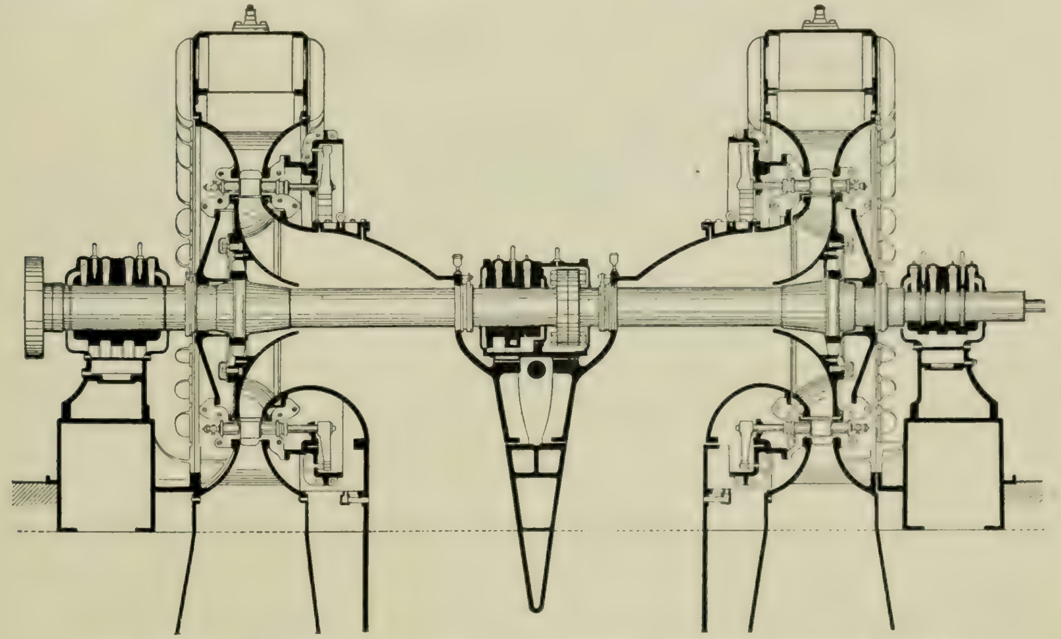
The figure below shows a vertical Francis turbine as installed in the Kykelsrud plant, Norway. It operates under a head varying from 52.5 to 62 feet, with a water consumption of 670 to 530 cubic feet per



VERTICAL SHAFT FRANCIS TURBINE, KYKELSRUD PLANT, NORWAY.

second and at 150 revolutions per minute it develops 3,000 horse power. It will be noticed that this turbine, as is usual in this type, has a spiral casing. The water enters this casing at a velocity of 9 feet per second, which is gradually increased to 20 feet, and discharges with a velocity of 3.9 feet per second.

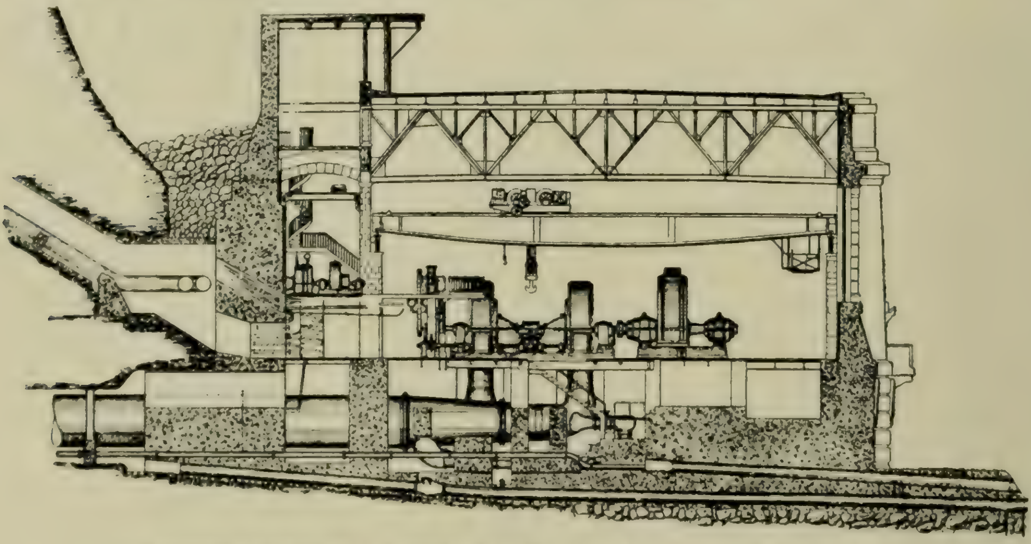
Below is shown the type of turbine in the Ontario Power Company's plant, designed to accommodate twenty-two turbines, of which ten are at present installed. They are of the horizontal Francis type, built by Voith, Heidenheim, Germany. Two turbines are mounted on a single shaft arranged so as to balance the thrust, one of the three bearings, however, being a thrust bearing. Each wheel has its own feeder penstock connection, the two wheels discharging into a common draft tube located between the two runners. These runners are of cast-steel and are 78 inches in diameter; the housing is of structural steel, rectangular in plan and spiral in elevation, the diameter being 16 feet. They operate under a head of 175 feet, 20 feet of which is secured by the draft tube, and develop 12,000 horse power at a speed of 187.5 revolutions per minute.



TWIN FRANCIS TURBINE, 12,000 HORSE-POWER, ONTARIO POWER COMPANY.

The Francis and impulse wheels are the universally used wheels of the high-head type. Probably the highest head developed is that at the Vouvry plant, near Lake Geneva, Switzerland, the head being, 3,116 feet. It may be of interest to state that probably the lowest head utilized is also found in this district, being 16½ inches.

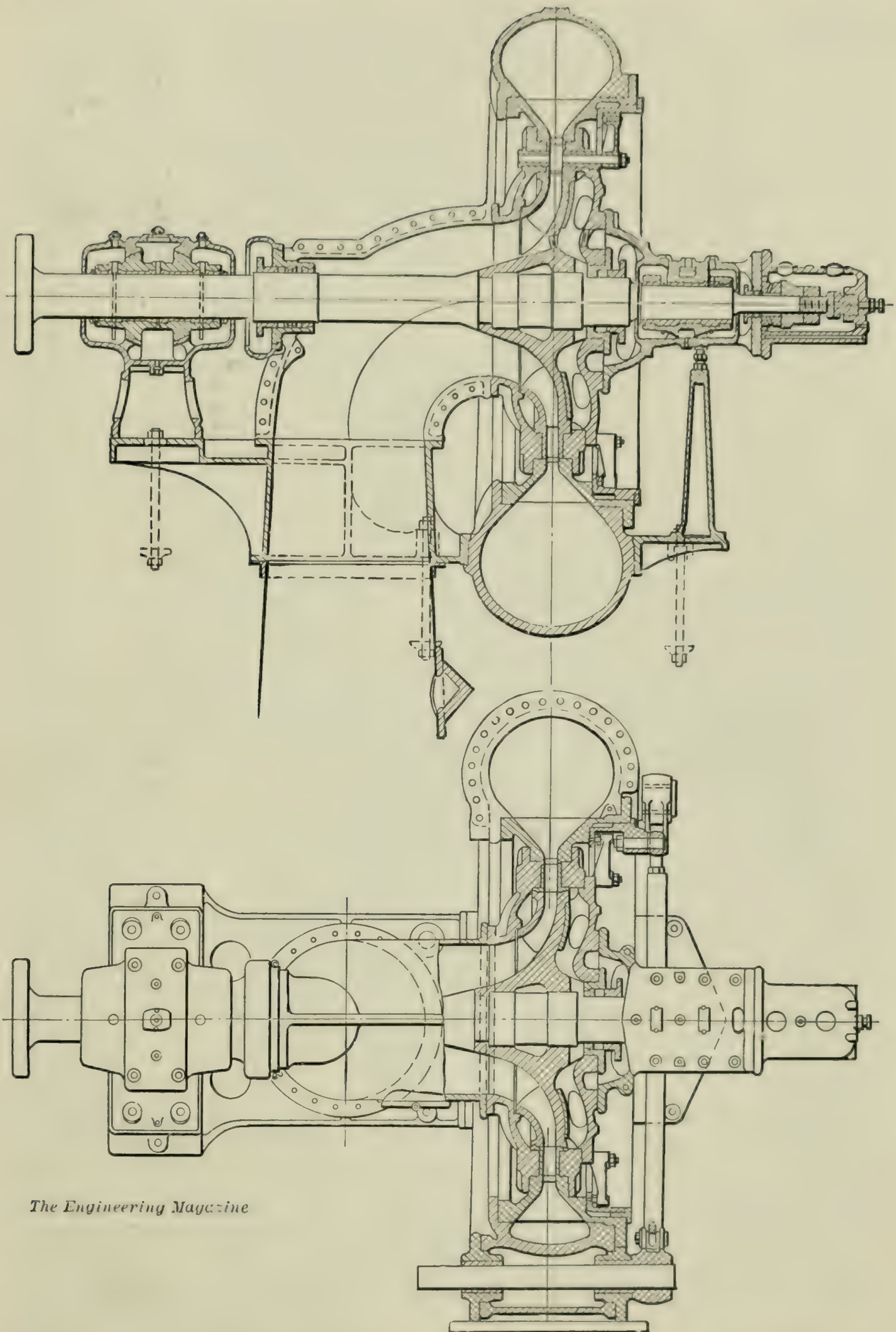
Of the high-head turbines used in America the most prominent type is the impulse, commonly called the Pelton wheel. This is a very simple machine; it consists of a wheel with a number of buckets mounted circumferentially. The wheel is usually mounted on a horizontal shaft, one or more on a single shaft. The water from the penstocks is directed against the buckets through one or more nozzles. Typical installations are those of the well-known Kern River plant of the Los Angeles Edison Company near Salt Lake City, Utah. In the latter case we find two wheels, mounted upon one shaft and enclosed in one casing, each wheel being provided with 24 cast-steel buckets, and operating under a head of 1,750 feet.



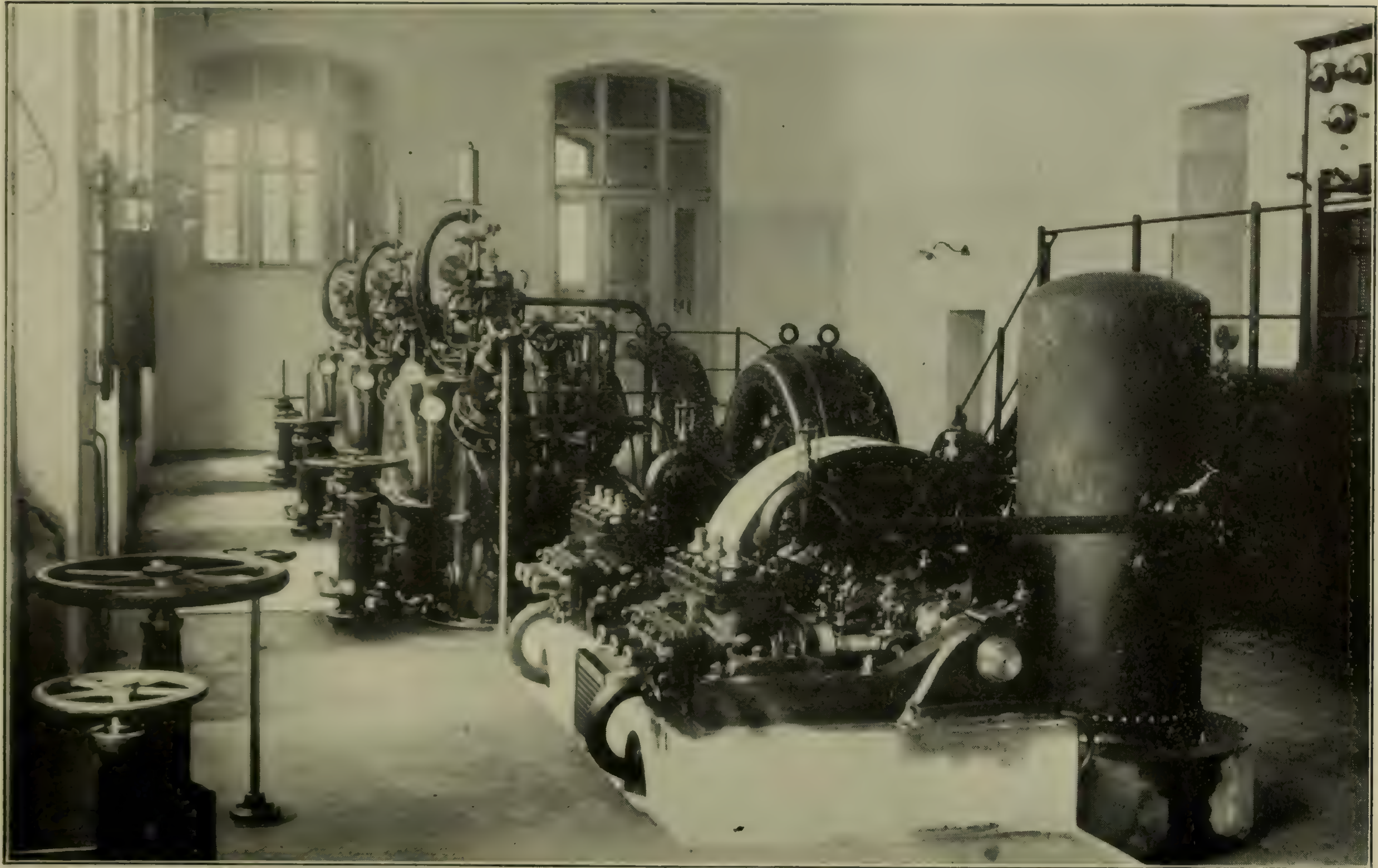
SECTION THROUGH POWER PLANT, ONTARIO POWER COMPANY.

As already stated Francis turbines are also used for high heads and page 357 shows a 9,700 horse-power turbine of this type as installed for the California Gas and Electric Corporation. It is designed to operate under a head of 550 feet, making 400 revolutions per minute. Until recently this turbine was known as the largest of this type ever constructed. However, 12,000 horse-power units have since been put in operation, and in the near future units of 17,000 kilowatts will be in service at the Rjukanfos plant in Norway. This plant, which is being built for the production of air-saltpetre (artificial nitrate), will have a first installation of five such units. It might be of interest to state that there is a great future for this product, for which several plants are already in operation and the ultimate aggregate capacity will soon reach 400,000 horse power.

Wherever possible, turbines should be provided with draft tubes when additional head can be thereby secured While it is not usual to provide impulse wheels with draft tubes, this may be done in con-



9,700 HORSE POWER FRANCIS TURBINE, CALIFORNIA GAS & ELECTRIC CORPORATION.



POWER PLANT AT CHUR, SWITZERLAND, EQUIPPED WITH IMPULSE WHEELS FITTED WITH DRAFT TUBES.

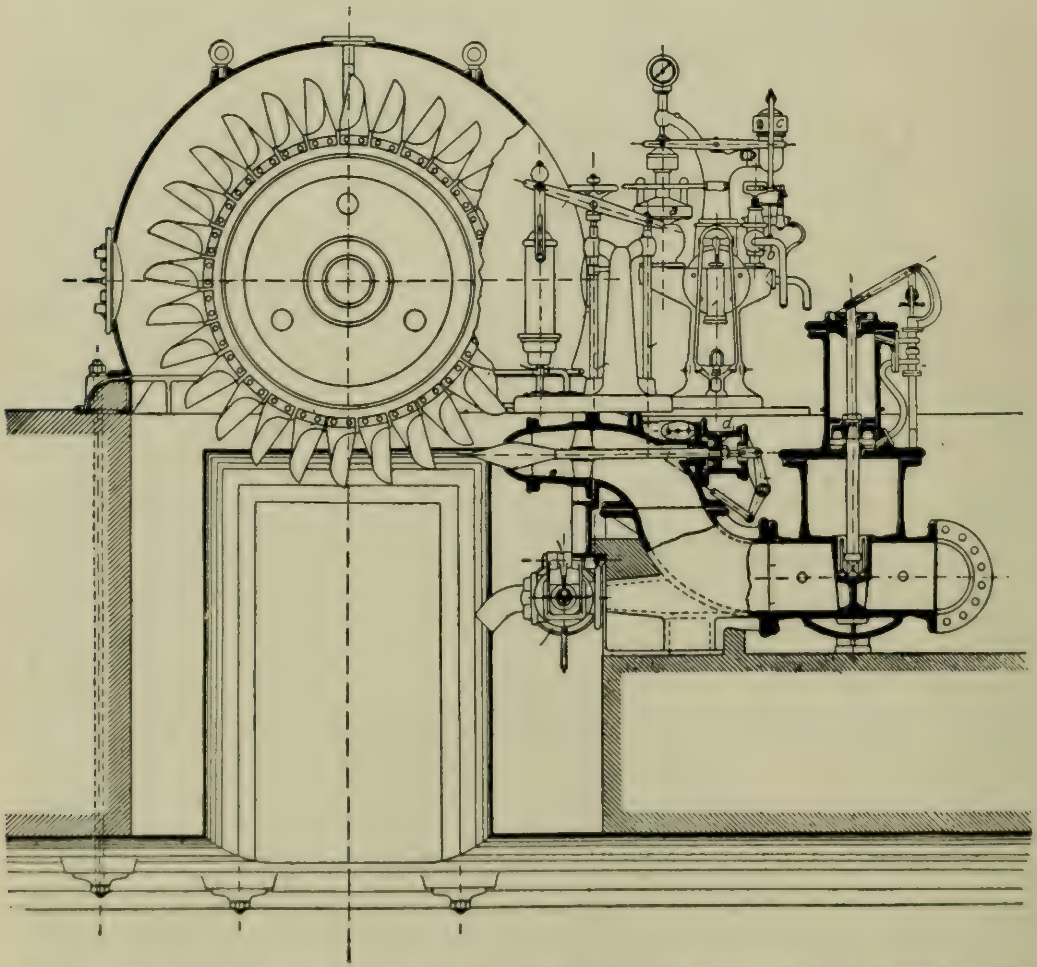
nection with small units, and we find an installation of this kind at Chur, Switzerland, where wheels of 250 horse power operate under a head of 272 feet, the head gained by the use of the draft tubes being about 15 feet When impulse wheels are so equipped the wheel must run in a partial vacuum, the water column in the draft tube being so regulated that the surface of the water in the draft tube is about 2 feet below the wheel. This is accomplished by providing the upper end of the draft tube with an air cock controlled by the governor.

The theoretical height of head that can be obtained by a draft tube is 34 feet, equal to the pressure represented by a perfect vacuum. However, on account of frictional loss and leakage, the head obtainable in practice by the use of the draft tube is much less, and decreases with the increase of diameter and *vice versa*. According to Meissner, the practical heads due to draft tubes are as follows, the dimensions being converted into feet and given in round numbers:—

Diameter of Draft-tubes in Feet	Draft Head in Feet
2	27
4	21
6	17
8	14
10	12

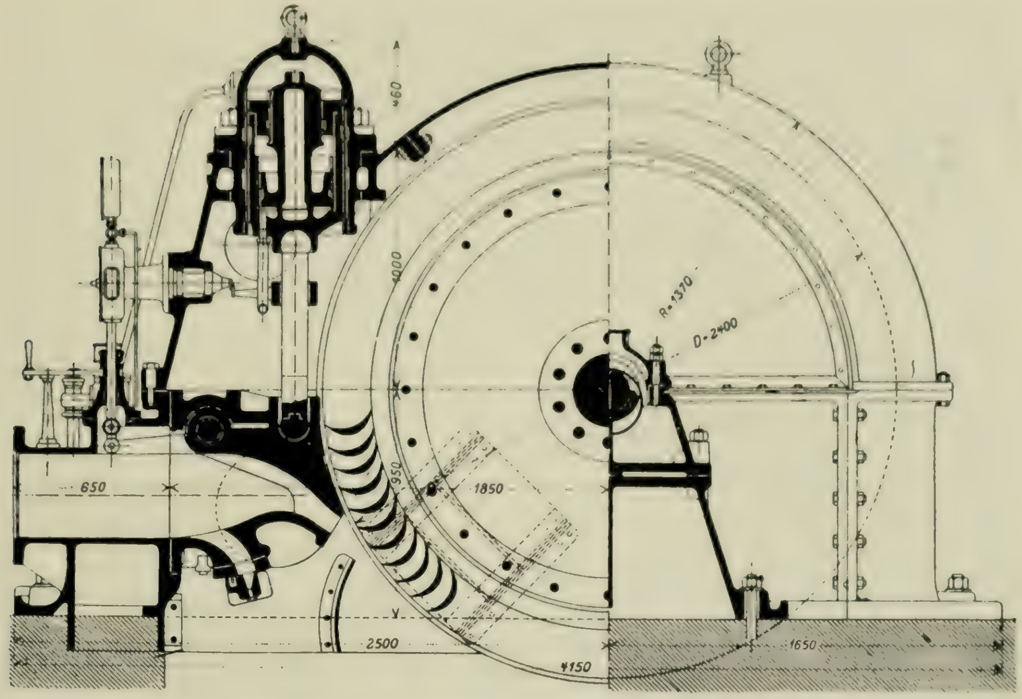
Draft tubes should always be made conical, with the large end at the bottom, so as to reduce the velocity of discharge, and the upper end must be of the same size as the discharge outlet of the turbine so as to avoid abrupt changes in the velocity of the water. The velocity of discharge from the draft tube should be about 2 feet for low head, 3 feet for medium, and 4 to 7 feet for high-head turbines. All draft tubes should be as straight and free from bends as possible and the lower end must be water-sealed at least 6 to 12 inches for small-size and 18 to 24 inches for large-size turbines. They must be made strong enough to resist collapsing strain and must be properly anchored to avoid vibration.

Turbines and water wheels, particularly when coupled to generators as is the case under discussion, must be provided with efficient governing devices to maintain a nearly constant speed. The irregular operation in hydroelectric plants may have its origin in the hydraulic end, because of water hammer, surging in the penstock or draft-tube, or loss of vacuum in the latter, etc.; in the mechanical end, because of poor operation of the turbines and the supply gates, or controlling of waste water in case of sudden shut-downs which might arise from the hydraulic, mechanical, or electrical end of the station. There are, of course, other factors which may necessitate the choosing of a governor adapted to control load fluctuation for a particular plant; for instance, successful operation of a high-head plant may be accomplished in one case by a quick-acting and in another by a slow-acting governor. Where the load is steady a slow-acting governor gives the best results.



5,000 HORSE-POWER IMPULSE WHEEL WITH NON-WATER-WASTING NOZZLE AND GOVERNOR.

In addition to a governor, the turbine may be provided with a special fly-wheel. A good designer, however, considers a fly-wheel in connection with a turbine governor as an unnecessary adjunct, as the runner of the turbine or the revolving field of the generator should be designed to serve the same purpose. A plant with a great fluctuation in load is best controlled by quick-acting governors and such may be provided with auxiliaries to by-pass the water into the tail-race, as otherwise the sudden cut-off of the moving column of water will set up violent surges, and liability of damage to governor as well as pen-

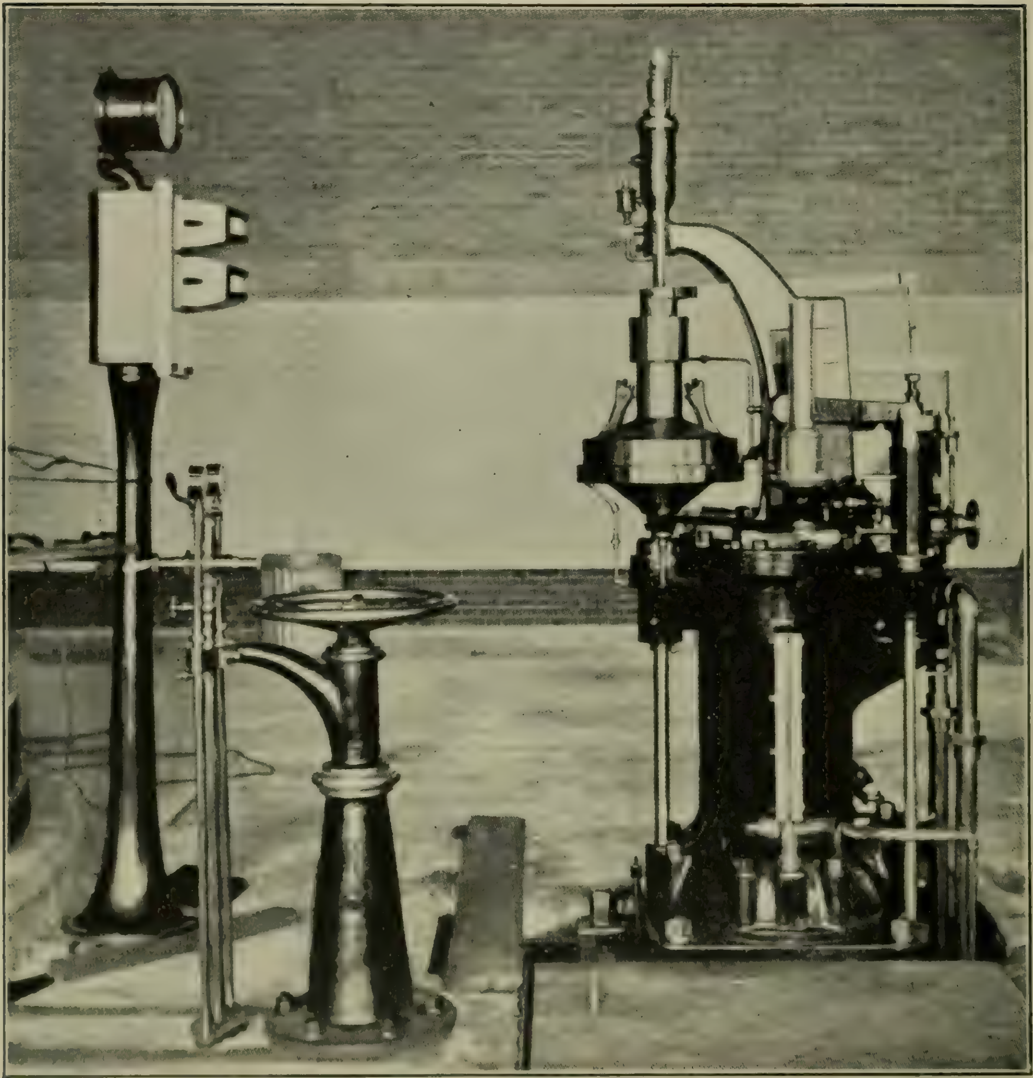


SPOON-WHEEL TURBINE AND GOVERNOR, OBERMATT PLANT, SWITZERLAND.

stock may occur. To prevent an excessive waste of water the governor should be designed to close the supply through this by-pass as soon as the shutting-off of the turbine is complete.

A governor of this type which has been installed in the Brusio Plant and also in many other prominent plants is shown on page 360. As will be seen the nozzle is stationary, while the needle is moved to and fro by a piston controlled by the governor which also actuates the by-pass located in the continuation of the penstock. The main valve closes simultaneously with the by-pass. The figure above is another type of Swiss governor used in connection with a so-called spoon-wheel turbine. It is operated by means of gearing from the main shaft and adjusts the opening of the jet by means of an oil-actuated piston device. The nozzle opening is 6 by 3.5 inches and the port opening is varied by a hinged jaw. The opening and closing action of the by-pass takes place simultaneously with that of the nozzle. As with the previously described governor, the closing of the main valve is by automatic action and can be accomplished in 20 seconds, while the action of the governor in throwing off the full load (2,500 horse power) requires 2 to 2.5 seconds, giving, after 6 seconds, a speed regulation of 4 per cent.

There are several more or less popular regulating devices on the market such as the Lombard, Pelton, Replogle and Glocker, etc. As



GLOCKER-WHITE GOVERNOR.

the operation of the Pelton governor is different from the European governors employed in connection with impulse wheels the mode of operation is here given.

The usual method of controlling the speed of a Pelton wheel is by means of a deflecting nozzle, needle nozzle, or a combination of both, the type most suitable for use depending upon the conditions of head, power, and character of load. The deflecting nozzle, provided with a ball and socket joint, is raised or lowered, thus throwing the stream on or off the buckets. The power of the wheel is increased or diminished accordingly as the load varies. A steel deflecting plate which deflects the stream itself is sometimes used to accomplish the same result when the design will not admit of a deflecting nozzle.

The needle nozzle consists of a nozzle body in which is inserted a concentric tapered needle, a change of position corresponding to a change in the discharge area of the nozzle.

Plants continue to be installed in which, when impulse wheels are shut down, the entire supply of water is directed from the wheel and wasted through the tail-race instead of being so controlled that this water may be stored or impounded behind properly designed dams as a reserve for dry seasons, thus doing away with the necessity of an auxiliary steam or gas-engine plant to meet such emergency. Wasting water in this way has another great disadvantage, inasmuch as this water, on account of the great force with which it is discharged into the tail-race or river below, will wash out the earth and endanger the foundations of the structure. At a notable installation in California such waste water is causing a considerable washout. This may be overcome by directing this waste water into the tail-race without having any injurious effect upon foundations through the washing away of surrounding earth. Such provision was made in connection with the Kern River Plant No. 1 at Los Angeles, by installing heavy curved deflector plates of steel so designed as to direct the water through two right angles before it is allowed to pass into the tail-race.

Power-plant designers should accept only such guarantee tests as are made in the power plant itself under the regular operating conditions. With such policy, which is strictly adhered to in Europe, higher efficiencies will be obtained in the future.

METAL-WORKING PLANTS AND THEIR MACHINE-TOOL EQUIPMENT.

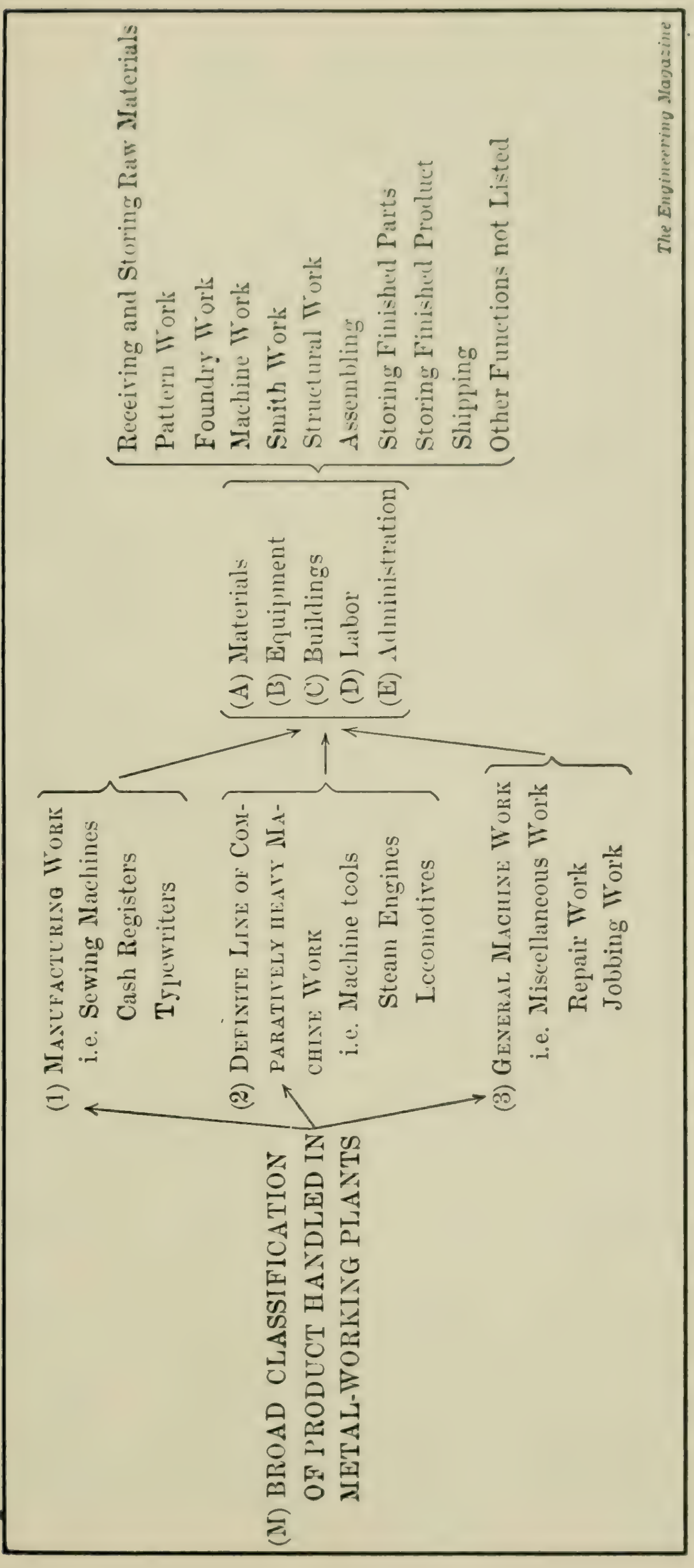
By Charles Day.

In this article and a second on the same topic, to follow next month, Mr. Day analyzes the machine-tool equipment of metal-working plants—not in detail, but in general character as influencing especially the design, layout and structural features of the buildings. This first part covers the general classification and the characteristics of general metal-manufacturing establishments. The July section will consider heavy and general machine-tool shops. —The Editors.

IN four articles published in The Engineering Magazine, September to December, 1909, the manner in which the work of planning and building industrial plants should be carried out was analyzed, formulated, and discussed. Consideration was given primarily to certain broad principles governing this work irrespective of the output for which the plant is designed. Knowledge of these principles is effective only when it is coupled with a thorough understanding of the special requirement of the particular business we are providing for. The next logical step in the development of this subject is, therefore, the study of the characteristics of the particular type of plant most interesting to the large majority of those concerned with the engineering industries. This is the plant whose predominant function is the working of metals.

Even here specific requirements vary widely in different branches of the metal trade. Conditions are not exactly the same in any two cases. Nevertheless, metal-working plants have well defined characteristics which can be classified according to the specific aims of the particular establishments included in the general category. I do not propose now to include in this group smelting or reduction of crude materials to metallic form, nor the making of castings; but only those manufacturing establishments and (more particularly) the machining departments, in which metals are converted into ultimate commercial products such as machine-tools, automobiles, sewing machines, electric generators, watches, etc.

The various kinds of plants under consideration will be divided into three groups, depending upon the character of their output (Chart 1, page 365). The nature of most metal-working businesses



The Engineering Magazine

is such that they do not fall wholly within the clear confines of any one of the groups, although in almost every case there is a predominating tendency toward one of them. It will be shown that the exactness of solution that can be attained when laying out a new plant differs in degree quite markedly for each of the groups, being a maximum in the first and a minimum in the third. A proper understanding of this condition results in a much clearer conception of the whole subject of metal-working-plant.

The conduct of all businesses coming under the classification in question involves five factors, *i. e.,* Materials, Equipment, Buildings, Labor, and Administration. Each of the departments or kinds of work indicated to the extreme right of the chart comprises all of these factors, the names being merely indicative of the functions performed. This self-evident fact is alluded to only because it is the purpose to show that while machine work, smith work, the storing of parts, etc., are common to all of the plants coming within the classification, yet the manner of providing for and administering each of these has well defined characteristics which can be logically sub-divided for the purpose of analysis in accordance with the three groups given in the chart. These characteristics are briefly referred to below and can be identified by the letters and numbers corresponding to the divisions of the chart.

I wish to emphasize that this analysis is for the purpose only of setting forth some of the more important requirements of metal-working plants in a manner that may possibly prove helpful to the engineer engaged upon this work, through giving him a more comprehensive understanding of the limits attainable in the satisfaction of the conditions imposed by the principal branches of the metal-working industry.

M—(1) MANUFACTURING WORK.

(Characteristics.)

M (1) a—Materials—Usually of such a character and required in such quantities that they can be readily handled and stored through the provision of special tote boxes, racks, bins, etc.

M (1) b—Equipment—Principally special in character; sometimes available as stock machinery, otherwise built to order in accordance with special designs.

M (1) c—Buildings—Single-story or more often multiple-story—of types standard for such structures considered on their own account, the product not being an influencing factor.

M (1) d—Labor—Comparatively low-grade help skilled in the performance of single operations, excepting a small part of the force composed of high-class mechanics.

M (1) e—Administration—Clearly defined conditions as to materials, equipment, and functions of employees permits of the most ready establishment of a fixed policy as to operating methods and provisions for expansion.

M (1) a, b, c, d, e—The problem of plant layout for industries in this group permits more readily of exact solution than for either of the groups that follow. Equipment is largely special. Buildings are of standard types suited to property conditions. Administration methods are capable of accurate definition, and standards can be adhered to owing to the repetitive feature of the manufacture. The final layout of equipment and buildings indicates directly (to a very considerable extent) the desired method of operation.

M—(2) HEAVY MACHINE WORK.

(Characteristics.)

M (2) a—Materials—Usually comparatively heavy, quite diversified and bulky, so making the solution of handling and storing methods more difficult than for shops in the first class, although reasonably fixed conditions are presented.

M (2) b—Equipment—Generally stock machine tools, adapted to a considerable range of work as compared with the wholly special equipment characteristic of the first class.

M (2) c—Buildings—Special to suit the size of the work performed in them, and incorporating structural features that are used in the same sense as equipment.

M (2) d—Labor—A predominating part properly experienced in respective trades, not merely skilled in the attendance of machines performing single operations.

M (2) e—Administration—Conditions as to materials and equipment and functions of employees are not capable of standardization in the sense that is practicable in shops of the first class, so that intelligent direction of the work requires the constant application of scientific methods based upon elemental understanding of all factors involved and applied through carefully devised system.

M (2) a, b, c, d, e—The problem of plant layout for industries in this group is the most complex; for, while capable of reasonably definite solution, the greatest variety of factors is presented. Equipment is largely comprised of standard types of machines. Buildings are special. Administration is complex. The final layout of equipment and buildings suggests directly only in small measure the method of operation intended.

M—(3) GENERAL MACHINE WORK.

(Characteristics.)

M (3) a—Materials—The character and amount of materials can be anticipated only in small part, owing to uncertainty of kind of work that will be done. Consequently, there is imposed a wide demand upon the receiving and stores departments.

M (3) b—Equipment—Principally stock machines suited to very wide range of work. Occasionally special machinery for possible repairs on special parts. Selection of types and determination of amount of equipment can be approximated only.

M (3) c—Buildings—The character of work to be done is usually a governing factor in their design. Precise definition of types and sizes is, however, seldom practicable.

M (3) d—Labor—Especially versatile in respective trades. Possibly not so capable at any one job as operators in shops of second class, but competent throughout a much wider range of performance.

M (3) e—Administration—The system of management must be the one that will prove most effective under circumstances that make it impossible to anticipate exact conditions from day to day. Each case must be worked out along special lines and often conditions are such as not to justify a highly perfected system.

GENERAL MACHINE WORK.
(Concluded.)

M (3) a, b, c, d, e—The problem of laying out plants coming within this group is capable of the least definite solution. Equipment is largely standard, suited to wide range of work. Buildings standard or special, depending on the kind of work that is desired. Administration methods must be suited to the uncertain conditions and, while in one sense the conditions call for the most highly perfected system, incidental conditions prohibit or do not justify their introduction. In any case, it is system that works from day to day and cannot plan for the future.

The purpose of classifying our subject in the manner given above was, primarily, to provide a logical basis for its discussion. We will now consider, individually, each of the factors composing the three principal groups.

M (1) a—Materials—Usually of such a character and required in such quantities that they can be readily handled and stored through the provision of special tote boxes, racks, bins, etc.

The term "Manufacturing Work" is used in the customary industrial sense—namely, the kind of work that involves the making of certain articles in very large quantities, the repetition of various operations being the essence of the manufacturing feature. The necessity of manufacturing in such large lots as we have under consideration arises principally in connection with articles that are purchased for individual use, such as watches, cooking utensils, typewriters, sewing machines, etc. Of course, there are exceptions to this rule such as the automobile, but even in its case the actual manufacturing operations are performed upon comparatively small parts.

Consequently, materials purchased by manufacturing concerns are characterized by their comparative lightness and the fact that they are required in great quantities. Therefore, the stores department can be laid out with very considerable accuracy, providing special bins and racks for the storage of different material and they can be efficiently transported in lots through the use of tote boxes or other equipment adapted particularly to them.

M (1) b—Equipment—Principally special in character, sometimes available as stock machinery, otherwise built to order in accordance with special designs.

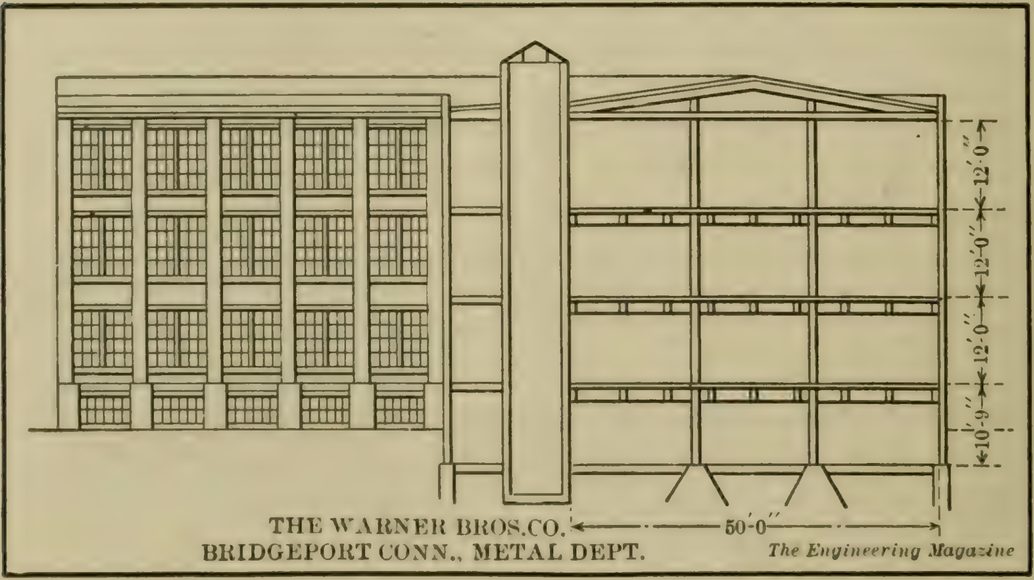
The types of special equipment used in manufacturing plants are designed ordinarily for the performance of but a single job, or in many cases, but for a single operation. Frequently, however, adjustments are provided which permit of the performance of other jobs or operations which are of the same general kind, but usually special equipment is used exclusively for the performance of certain fixed operations. There is special machinery for which there is so large a demand that it is a regular line of output of certain of the machine-tool builders; and then again, the machinery used to manufacture special articles which, either through patent protections or for other causes are made only by one or at the most a few concerns, must be built to order in accordance with special designs. The ability exercised in the design of such equipment has, necessarily, a very great bearing upon the efficiency of the plant, as the amount of output is directly dependent upon the performance of the machines themselves.

It is particularly in regard to equipment designed for the manufacture of articles for which there is a large demand that standard types have been perfected, the use of which can be counted upon when laying out a new plant. It is not practicable as a general thing for the engineer who is engaged upon such work to take under consideration the design of process apparatus or special machinery. Therefore, he is confronted with a very specific problem in so far as equipment is concerned.

M (1) c—BUILDINGS—Single-story or more often multiple-story—of types standard for such structures considered on their own account, the product not being an influencing factor.

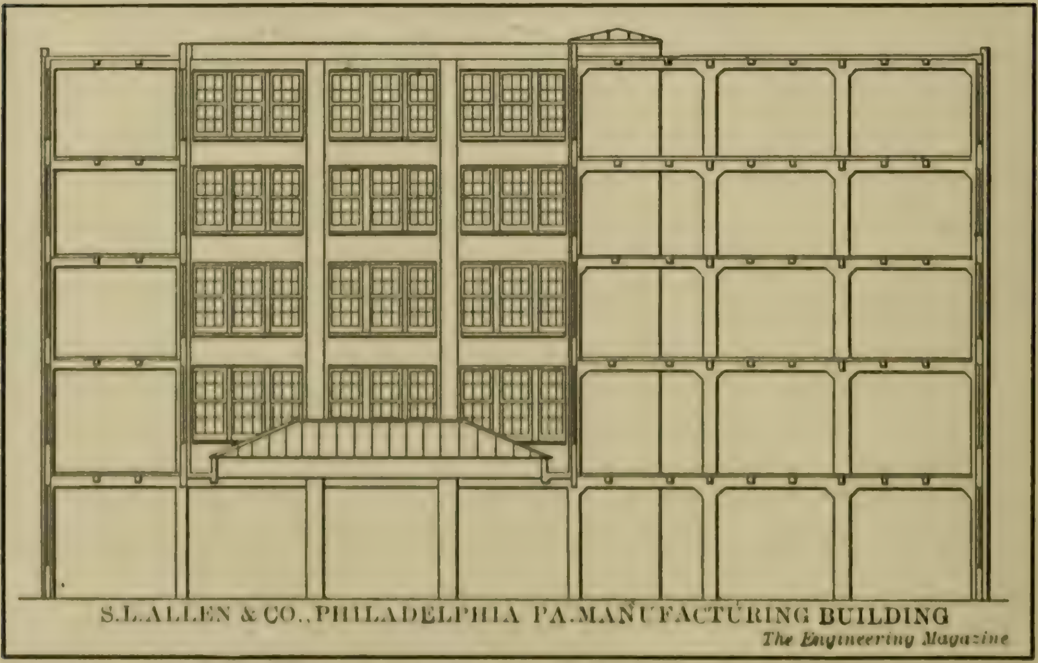
Several functions are performed by the buildings used to house industrial work, the more important of which are; first, to afford protection against unfavorable weather; second, to allow of a floor area greater in the aggregate than the area of the property occupied (accomplished through the adoption of multiple-story structures); third, to afford fire protection; and fourth, to serve in part as equipment through providing the means of support for line-shafting, traveling-crane runways, etc. The first three considerations usually govern for the class of work that we are considering. As manufacturing work is light in character, the amount of head room between floor and ceiling that is required for proper light and ventilation (which is satisfactory for light overhead line shafts), is found to be adequate. Therefore, the building structures are not governed specifically by the detail processes of manufacture, but are types suitable for various other classes of occupancy. It is often desirable, from the standpoint of investment, to assure the fulfilment of this condition even if slight industrial disadvantages result.

The sketches below show buildings of multiple-story type suited to general manufacturing operations. The illustrations on following pages exemplify buildings belonging to the second and third groups in the classification here adopted—that is, to definite comparatively heavy machine work or to general machine work. They are shown here for comparison though their specific discussion will not be taken up until next month.



THE WARNER BROS.CO.
BRIDGEPORT CONN., METAL DEPT.

The Engineering Magazine



S.L.ALLEN & CO., PHILADELPHIA PA. MANUFACTURING BUILDING

The Engineering Magazine

TYPICAL BUILDINGS SUITED TO THE REQUIREMENTS OF THE FIRST, OR "GENERAL MANUFACTURING," GROUP IN THE CLASSIFICATION ON PAGE 365.

M (1) d—Labor—Comparatively low-grade help skilled in the performance of single operations, excepting a small part of the force composed of high-class mechanics.

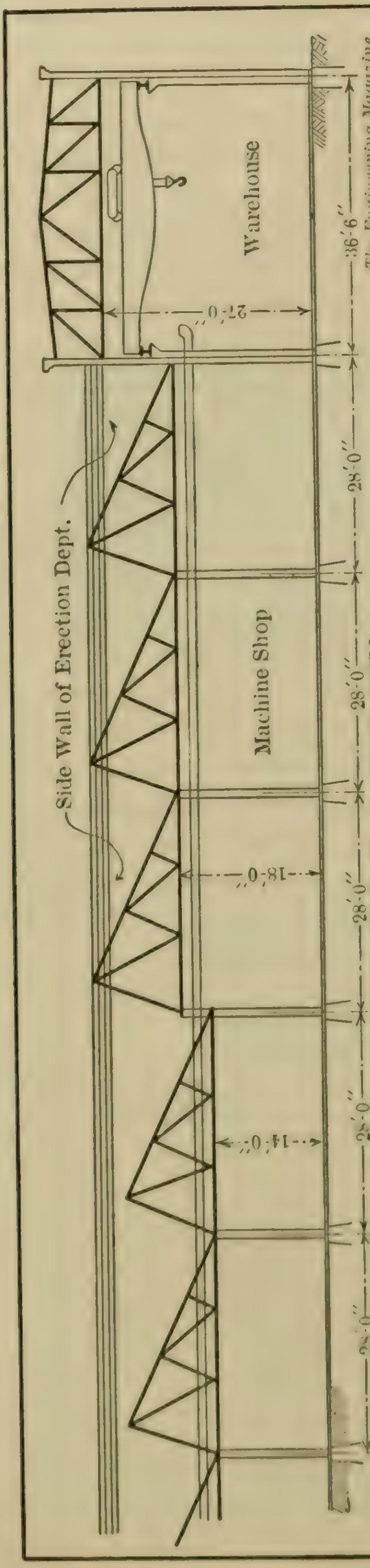
When the character of the work is such as to lend itself to manufacture by means of special and automatic machinery, highly skilled operators are usually needed only for the performance of certain auxiliary functions—that is, the special machinery may require attendants whose entire duty it is to furnish the work to the machine and to remove the finished product. While this may necessitate a considerable amount of dexterity upon the part of such operators, the work is of such a nature that comparatively low-grade help can be trained to a high point of efficiency. The great advantage these manufacturing methods afford is that quality and quantity of work done are almost wholly beyond the control of the machine attendants. As a rule the class of operators just referred to are more readily disciplined than skilled artisans. The question of their segregation arises only when it is necessary to meet objections that may be advanced by skilled workers.

The maintenance of conditions that permit the employment of low-grade men is made possible, however, only through the fact that a small force of very high-class mechanics is engaged to make all of the dies, jigs, templets and other special accessories, and conditions favorable to their most efficient performance must be established. It is often desirable to segregate these men, and when their work has to do with the product in only an indirect manner, their services are made available to a number of departments turning out products which in themselves are quite different.

M (1) e—Administration—Clearly defined conditions as to materials, equipment and functions of employees permits of the most ready establishment of a fixed policy as to operating methods and provisions for expansion.

The purpose of a system of administration is to provide the executive with means for securing the results for which the plant is operated; viz., the manufacture of a certain output complying with fixed standards as to quality and made in certain definite quantities.

The administration of manufacturing plants is facilitated through the fact that the quality of the product is governed largely by the performance of machines, not operators, and that a fixed output can be secured for a given equipment. Fixed output under uniform conditions of attendance should result in uniform operating costs; the



CINCINNATI BICKFORD TOOL CO., OAKLEY OHIO

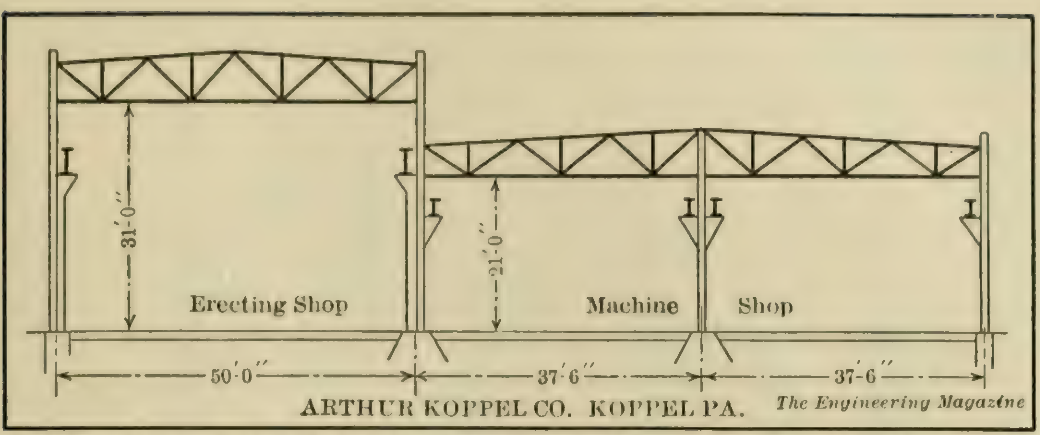
A TYPICAL CONSTRUCTION FOR A PLANT DEVOTED TO MODERATELY HEAVY SPECIAL MACHINE WORK.

A high bay for the warehouse department, one perpendicular to it for erecting large equipment, and large saw-tooth roofed area for machining departments.

costs being low because the volume of work justifies special equipment, and uniform on account of the regularity of the output.

Owing to the fact that in the main standard types of buildings are suited to manufacturing work, it is usually a comparatively simple matter to provide for extensions through the construction of additional units of the same character, although when new buildings are occupied there is usually required a reapportionment of space in the original plant.

Owing to the special character of the equipment, there is no doubt as to the work which must be performed upon it, and even though there are a great number of parts entering into the product, the question of routing is a comparatively simple one, and the routing plan that is adopted is to a considerable extent made apparent by the layout itself. This is illustrated in a very simple form by a hat factory, where, if the trucks transporting the hats are removed in the manner made directly evident by the arrangement of the machinery in departments, they will practically mark out on the floor of the various buildings lines identical with those shown on the routing diagram (to appear in a subsequent article) and this would be true if those who operated the plant had never seen the diagram in question.



A MACHINE-SHOP FOR MANUFACTURE OF CONTRACTORS' DUMP CARS, INDUSTRIAL RAILWAYS, ETC. SPECIAL WORK OF MODERATELY HEAVY CHARACTER.

M (1) a, b, c, d, e—RESUMÉ.

Owing to the precision with which most of the fundamental requirements of manufacturing plants can be defined, it is clear that they can be laid out with a very great degree of accuracy. The performance of special equipment is absolutely definite in character. The amount of such equipment required can be calculated with precision, and the amount of enclosed floor space needed can be readily ascertained after layouts of equipment have been made. Except for the buildings themselves, the entire plant is special in character and, in fact, this is true to such an extent as to make the layout as a whole useful in connection with the manufacture of but a single line of output. The number of plants that can be classed properly in the group we are considering is rapidly increasing owing to the tendency toward specialization which has become so marked a factor within recent years.

There are so many kinds of special equipment, that it will not be practicable to include actual illustrations in this article,* particularly as many of them are familiar to the reader. The influence of the character of the work upon the types of buildings is, however, so very marked and interesting that a number of illustrations are given showing cross-sections of certain existing shops that have been designed for particular lines of metal work. The small metal parts for the corsets manufactured by The Warner Brothers Company of Bridgeport, Conn., in the buildings shown in cross-section on page 370, are turned out in sufficient quantities to secure the full benefit of manufacturing methods. This condition is also well exemplified in

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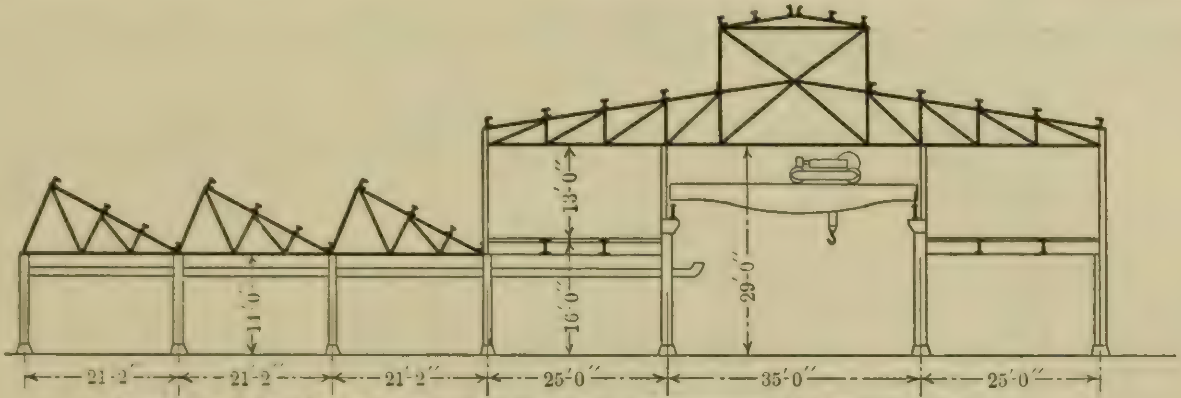
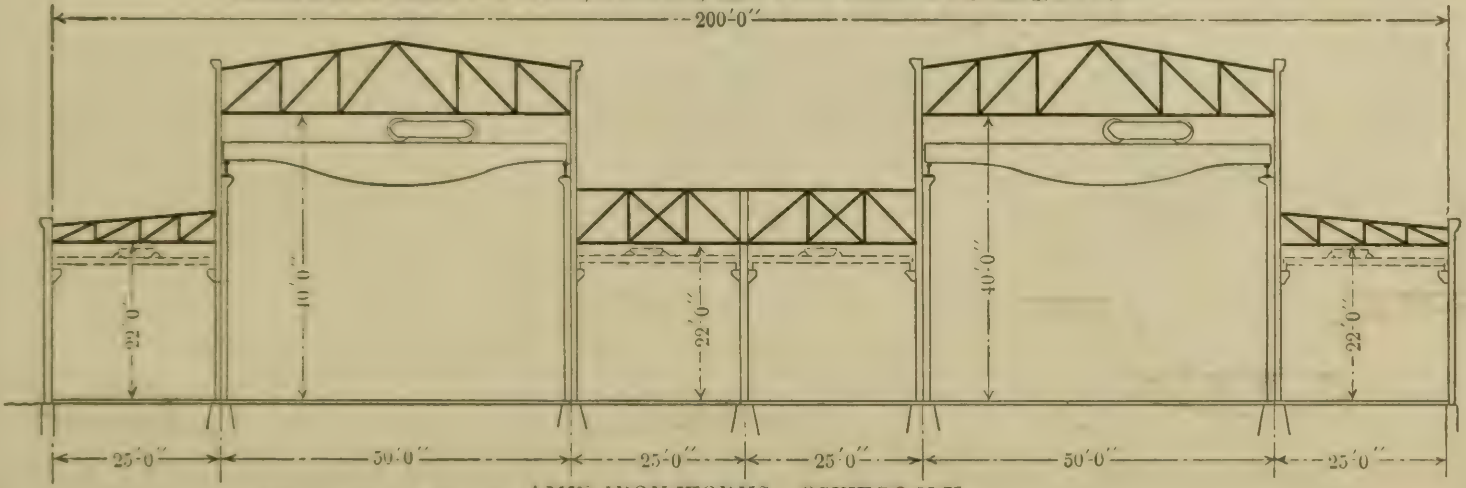
* Mr. Day dealt with machine-shop equipment in considerable detail in two articles that appeared in THE ENGINEERING MAGAZINE for July and August, 1909.

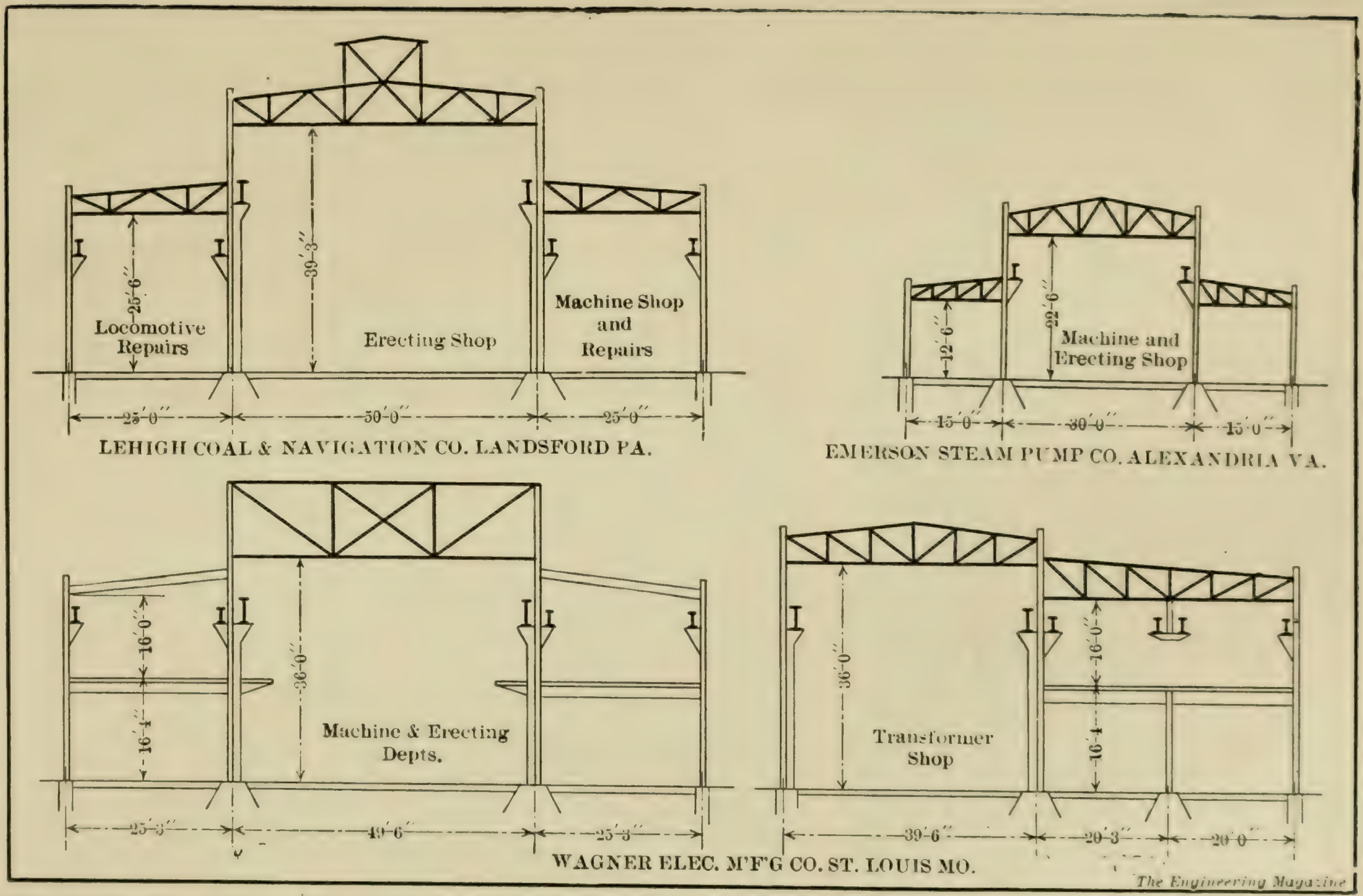


BARNARD & LEAS M'F'G CO., MOLINE, ILL. PROPOSED MACHINE SHOP



AMES IRON WORKS., OSWEGO N.Y.
PROPOSED BOILER SHOP.

PLANTS ILLUSTRATIVE OF ADAPTATION TO SPECIAL REQUIREMENTS OF MODERATELY HEAVY MACHINERY BUILDING.


LEHIGH COAL & NAVIGATION CO. LANDSFORD PA.

EMERSON STEAM PUMP CO. ALEXANDRIA VA.

WAGNER ELEC. M'F'G CO. ST. LOUIS MO.

The Engineering Magazine

THE LEHIGH COAL & NAVIGATION SHOPS BELONG TO THE THIRD CLASS—REPAIR AND JOBBING WORK; THE OTHERS, TO THE SECOND CLASS, OF SPECIAL MACHINE SHOPS.

Note the dimensional difference between the Lehigh Coal & Navigation and the Emerson Steam Pump Shops. Note also division of areas for machine and transformer work and provision of galleries for the lighter operation in the Wagner shops.

the building (shown in cross-section on page 370) in which have been housed certain of the principal departments of S. L. Allen & Company of Philadelphia, manufacturers of light agricultural implements. It is clear that the structures in question, which are of the multiple-story type, were designed primarily to provide the necessary floor areas in connection with the available property, but that it was possible to work up the structural details to satisfy building requirements upon their own account as the character of the work was not a governing factor. Thus it will be seen that these buildings could be used advantageously for other purposes than those directly intended, providing the floor areas were sufficient.

The concluding part of this discussion next month will take up buildings adapted to special and general machine work, with further reference to the illustrations of that type presented this month. These illustrations will be then introduced again for convenience of reference.

HYDRAULICS OF THE CHAGRES RIVER.

By Gen. Henry L. Abbot.

The real problem of the Isthmian Canal is one of hydraulics—not, as very generally assumed, merely one of navigation or finance. General Abbot's exact and authoritative studies, published in The Engineering Magazine, were among the most important arguments leading originally to the selection of the right project. We are glad to be once more the medium of giving publicity to this paper, prepared at the instance of the National Academy of Sciences (April, 1910) answering affirmatively and emphatically the question, lately raised, as to the sufficiency of the water supply even with the huge locks provided by the present plans.—The Editors.

IN projecting a canal across the Isthmus of Panama, the dominating element is not the volume of excavation at the Continental divide, but rather the hydraulics of the Chagres River whose valley must be traversed throughout the greater part of the route. The failure to appreciate this fact largely contributed to the disaster of the first French Company, and it is through the elaborate investigations of the New French Company, supplemented by those now in progress, that the problem has become perfectly understood. The climatic conditions are of primary importance in a study of the hydrology of the river, and they are so different from those of the United States that it is not without interest to contrast them.

The average annual temperature is about 80 degrees F., differing only about 2½ degrees in winter and summer. Ice and snow are unknown. The rainfall is much less irregular than with us, being largely governed by the motion of the sun in declination. The latitude of the Isthmus is about 9 degrees north, and as the sun moves north and south between the tropics it carries with it an ascending current of moist air which, condensed by cold, forms a rain-belt varying in latitude from month to month. Its passage over the Isthmus forms two well-marked seasons; three comparatively dry months, February, March, and April when the sun is far south; two intermediate months, January and May; and seven very rainy months forming the rest of the year. The absence of frost and the comparatively normal rainfall in this region greatly assist hydraulic studies.

It may naturally be asked what river in the United States, where the climatic conditions are so different, most nearly resembles the

Chagres in respect to volume of discharge, and thus illustrates the effect of these differences. The Roanoke River of North Carolina affords a good standard of comparison. Above Neal its drainage basin covers an area of about 87,000 square miles with an annual rainfall of about 51 inches. The studies of the New French Company included the basin of the Chagres above Bohio, where the projected dam was located, and where the stream at extreme low water nearly attains the level of mean tide. Above this point the drainage area is about 700 square miles, and the annual rainfall is about 112 inches. In respect to volume at ordinary stages the two rivers are very similar. Simultaneous gaugings in 1896, made respectively by the U. S. Geological Survey and the New French Company for five consecutive months, indicated almost identical discharges—about 5,800 cubic feet per second. The maximum recorded floods of the two rivers indicate 113,000 feet-seconds for the Chagres and 83,000 for the Roanoke, the height attained above low water being respectively about 40 feet and 30 feet. At low stages the Roanoke carries the larger volume—as might be expected since its drainage basin is more than twelve times as large.

The topography of the Isthmus also exerts a controlling influence upon the hydraulics of the river. The stream heads in the Cordillera de San Blas forming part of the Continental divide, which is here composed of ridges about 2,000 feet in height with peaks from 1,000 to 2,000 feet higher. The river is formed by two main branches, the Pequeni heading near the Atlantic coast in a massive limestone region, and the Chagres in the Continental divide where hard trap rock abounds. The upper tributaries flow through canyons cut deeply in the rock, with numerous rapids and falls. The two branches unite at Dos Bocas about 19 miles above Gamboa, where the line of the Canal is reached. In this distance the fall in water surface at low stages is about 80 feet, with many rapids. The channel is often bordered by limestone bluffs undercut by the torrents and passing gradually below the stratified sandstone of the lower river. The entire region is covered with a dense tropical forest. Near Gamboa the general direction of flow changes nearly at right angles, from south-west to north-west, and the river joins the route of the Canal. Here the low-water surface is about 46 feet above mean tide. At Bohio 20 miles below it hardly differs from that of mean tide, although the distance to the sea is about 27 miles. The tidal range on this coast is insignificant, varying between half a foot and two feet; but the fact that the river in the last 27 miles of its course has little or no energy in reserve to transport its water to the sea, is one of the most important of its hydrology for canal purposes. The accumulation of water to supply the needful head causes Bohio to be the point where is noted in great floods the maximum rise, about 40 feet. Such natural conditions near the mouth are phenomenal. At New Orleans, 100 miles above the head of the Passes, the total range is only about 14 feet, to compare with 51 feet at Cairo more than 1,000 miles above.

Another peculiarity of the Chagres, which attracts the attention of an engineer, is the nature of the river bars—especially in the 11 miles of channel next above Gamboa. They differ widely in composition; some are of fine sand, others of pebbles, others of rounded stones three or more inches in diameter; there is little or no mixing of materials. The explanation will be found in the peculiar regimen of the river. In the dry season the Chagres is a gentle stream which, as we shall see, is largely fed by water percolating from the soil. In the rainy season its character is quite the reverse. The sudden cloudbursts upon the mountains, often lasting two or three days, create torrents in the smaller tributaries which uniting in the river bed pass down stream like great waves. In the narrow canyons of these headwaters the elevation of the water surface often attains heights of 40 or 50 feet in four or five hours. Several times the surveying parties were endangered by these rises, and indications were not lacking that in great floods they are largely exceeded. In the main stream the heights attained above low-water level are of course much less, but even here the volume carried may range in twenty-four hours from 2,000 to 40,000 or more cubic feet per second, with corresponding variations in transporting power which easily explain the sorting of the materials forming the bars.

Since 1883 automatic records have been made at Gamboa, showing hourly water levels, and their study has developed interesting facts. The normal height in the rainy season is about 10 feet above extreme low water, and the number and duration of the freshets above this height, year by year, afford a trustworthy estimation of the relative volumes carried and hence of the relative rainfall producing them. The annual average shows 19 freshets lasting 221 hours, ranging from 5 freshets lasting 37 hours in 1902 to 46 freshets lasting 709 hours in 1887. Furthermore the grouping of consecutive years is suggestive. From 1883 to 1894 inclusive, 12 years, the average annual number of freshets was 28, lasting 354 hours, while for the next 12 years it was only 10 lasting 86 hours. During the last two years the average has again increased, being 20 lasting 298 hours. It may be added that studies of the rainfall records and measured discharges of the river are in perfect accord in confirming this progressive variation in annual rainfall and stream flow. During the operations of the first French Company the most unfavorable conditions were the rule. Heretofore the American engineers have been specially favored, but the latest records suggest that a change may perhaps be apprehended in the near future. Excessive rainfall of course is unfavorable to rapid excavation and concrete laying. During last year the number of freshets was considerably above the average, being 27 lasting 466 hours, but it may be noted that they did not materially retard progress.

Aside from these considerable freshets, great floods are a characteristic feature of the regimen of the Chagres. They also occur periodically. The first of record since the opening of the Panama Railroad in 1855 occurred in 1879, and inundated all the low lands of the valley. Four more occurred between 1885 and 1893, these 9 years being included in the period of excessive rainfall; 12 years of exemption followed; since then two great floods have occurred, one in 1906 and the other in 1909. These floods are always of short duration, hardly exceeding 48 hours, but they carry immense volumes and submerge large areas in the lower valley.

The close vicinity of the route of the Canal to this turbulent river; the fact that near Gamboa its bed is about 45 feet above mean tidal level, demanding a complex system of dams and artificial channels to protect a sea-level canal against inundation, and the further difficulties caused by the excessive tidal range in the Bay of Panama, which may equal 20 feet twice daily, early convinced the engineers of the New French Company that a sea-level construction was out of the question, and that the Chagres must be regulated by a great artificial lake to be entered by shipping by means of locks, the only manner by which the torrential neighbor can be perfectly controlled. This decision entailed an elaborate study of the hydraulic conditions on the Isthmus in connection with the question of water supply for lockage in the dry season. The discharge of the river was regularly gauged, beginning in 1890, and a fund of information now of great value to American engineers was collected. Time does not permit even a summary of these hydraulic investigations, but one matter of interest from a scientific point of view may be considered, namely the ultimate disposition of the rainfall.

As is known to every one, of the rain which falls upon the surface of the earth one part flows directly to the sea through the channels of the rivers; another part soaks into the ground, of which much the larger portion gradually percolates to the river beds and thus reaches ultimately the same destination while the remainder is consumed in the subterranean chemical changes in progress; the third part is returned to the atmosphere by evaporation, either directly or through the medium of plant consumption. The relative percentage of these three parts has an important bearing upon the question of the water supply of a canal with locks, and was the matter to be elucidated. Many streams are known to receive large volumes of water by percolation through the ground, the amount depending largely on the geological character of the soil. The absence of frost and the exceptional regularity of precipitation on the Isthmus specially favor the study of this element of the problem.

The daily outflow at Alhajuela, Gamboa, and Bohio had been carefully gauged during about six years. The catchment basin above the latter covered an area of about 700 square miles, divided into three sub-basins of known area in which the average rainfall varied somewhat, but where a sufficient number of observing stations had been occupied to afford a fair knowledge of the relative and absolute precipitation in each. These data permitted a satisfactory analysis of the ratio between downfall and outflow throughout the entire district—the gauged outflow being of course transformed from the usual unit of cubic feet per second to the height in inches to which one square mile of surface would be covered by the flow, thus giving figures directly comparable with the rainfall in inches.

The resulting values of the ratio month by month revealed the laws governing ground-water flow. It was found that the minimum value, about 0.3, occurred in May; and that from that date the ratio regularly increased month by month to about 0.75 in November, when both rainfall and outflow are at their maximum. It then rapidly passed to fictitious values above unity, indicating an outflow larger than the rainfall; and so continued, reaching a maximum of about two units in February, to a date between March and April when it dropped rapidly to the minimum in May.

The explanation of these figures is manifest. The soil acts like a sponge; at the end of the dry season the subsoil water reserve has nearly or quite drained out adding little or nothing to the river flow; during the following rainy months its volume gradually augments, discharging more and more through the river bed, until when the dry months arrive its contribution constitutes by far the larger part of the entire flow. The determination of the numerical values of the ratio, month by month, permits an easy computation of the actual volumes of the ground-water flow. The annual average represents about one-third of the total rainfall. In round numbers the general results of the study indicated for each square mile of this tropical river basin an annual rainfall of 111 inches; a total outflow including ground water of 73 inches; and a surface evaporation, represented by the remaining rainfall, of 38 inches. As compared with the north-eastern portion of the United States these figures indicate about two and a half times the precipitation, three and a third times the outflow, and one and a half times the surface evaporation.

Since the American operations began, the same system of careful observations has been continued, with a large increase in the number of the rainfall stations; another six years have now passed, and it is not without interest to submit the records to the same analysis and thus to compare the results. This I have done, and find the accordance to be so extremely close that it suffices to present in tabular form figures showing the average results for the past twelve years. As all but the last year or two pertain to the minimum period of the progressive variation in rainfall, deductions from them in respect to the water supply of the Canal are certainly safe and conservative.

The available volume is demonstrated to be more than adequate, even with the immense locks provided for the accommodation of modern shipping.

RAINFALL AND OUTFLOW ABOVE BOHIO, 700 SQUARE MILES. TWELVE YEARS, 1898 TO 1909 INCLUSIVE.

				Outflow in feet-seconds.		
Months.	Rainfall inches.	Outflow inch-mls.	Ratio.	Total.	Direct-flow.	Ground-water.
January..........	4.55	5.74	1.26	3477	828	2649
February.........	1.18	2.40	2.03	1612	238	1373
March............	1.16	1.61	1.39	979	211	768
April............	3.77	2.05	0.54	1284	713	571
May..............	11.45	4.13	0.36	2509	2090	419
June.............	11.30	5.73	0.51	3592	2114	1478
July.............	13.75	7.29	0.53	4425	2504	1921
August...........	13.47	8.14	0.56	4940	2646	2294
September........	11.27	8.07	0.71	5055	2136	2919
October..........	13.63	10.01	0.74	6074	2463	3611
November........	18.25	14.19	0.78	8904	3425	5479
December.........	8.13	10.70	1.31	6499	1488	5011
Year.	111.91	80.06	0.71*	4113	1738	2374
Dry (3).........	2.04	2.02	....	1291	387	904
Rainy (9)........	11.76	8.22	....	5053	2188	2865

* Quotient of aggregates.

Having by actual measurements, and by deductions therefrom, reached a precise valuation of the probable monthly downfall and outflow from the catchment basin above Bohio, ground water included, it remained to consider the third element of the lock canal problem—the probable evaporation from the projected lakes. No direct observations to determine evaporation from exposed water surfaces had been made on the Isthmus; but they had been made on Lake Nicaragua for ninety-four months by the Walker Commission, indicating an average of 0.18 inches per twenty-four hours. That evaporation from the general surface of the country must be less than that from exposed water surfaces is certain; but the fact that rain falls at Bohio on 254 days out of the 365 days of the year, and at Gamboa on 204 days, (averages based on eleven years of records) would indicate that the difference between the two is probably not very material in this tropical region. At any rate a check upon the Nicaragua observations might be had by assuming that the residue of the rainfall after deducting the total outflow would represent the evaporation from the general surface of the country. This computation could not be made month by month, because the rate of flow of the ground water in reaching the river bed is unknown; but the mean annual figure representing a complete cycle is not affected by this circumstance. It indicated a loss by evaporation per square mile over the entire surface of the catchment basin above Bohio of 0.11 of an inch per twenty-four hours.

During the last three years direct evaporation measurements on exposed water surfaces have been made by the Commission—for two years at Bas Obispo near the middle point of the Isthmus, for two years at Cristobal on the Atlantic coast, and for two years at Ancon near the Pacific coast. The figures differ but little at the three stations, and may be thus summed up, expressed in inches evaporated per 24 hours.

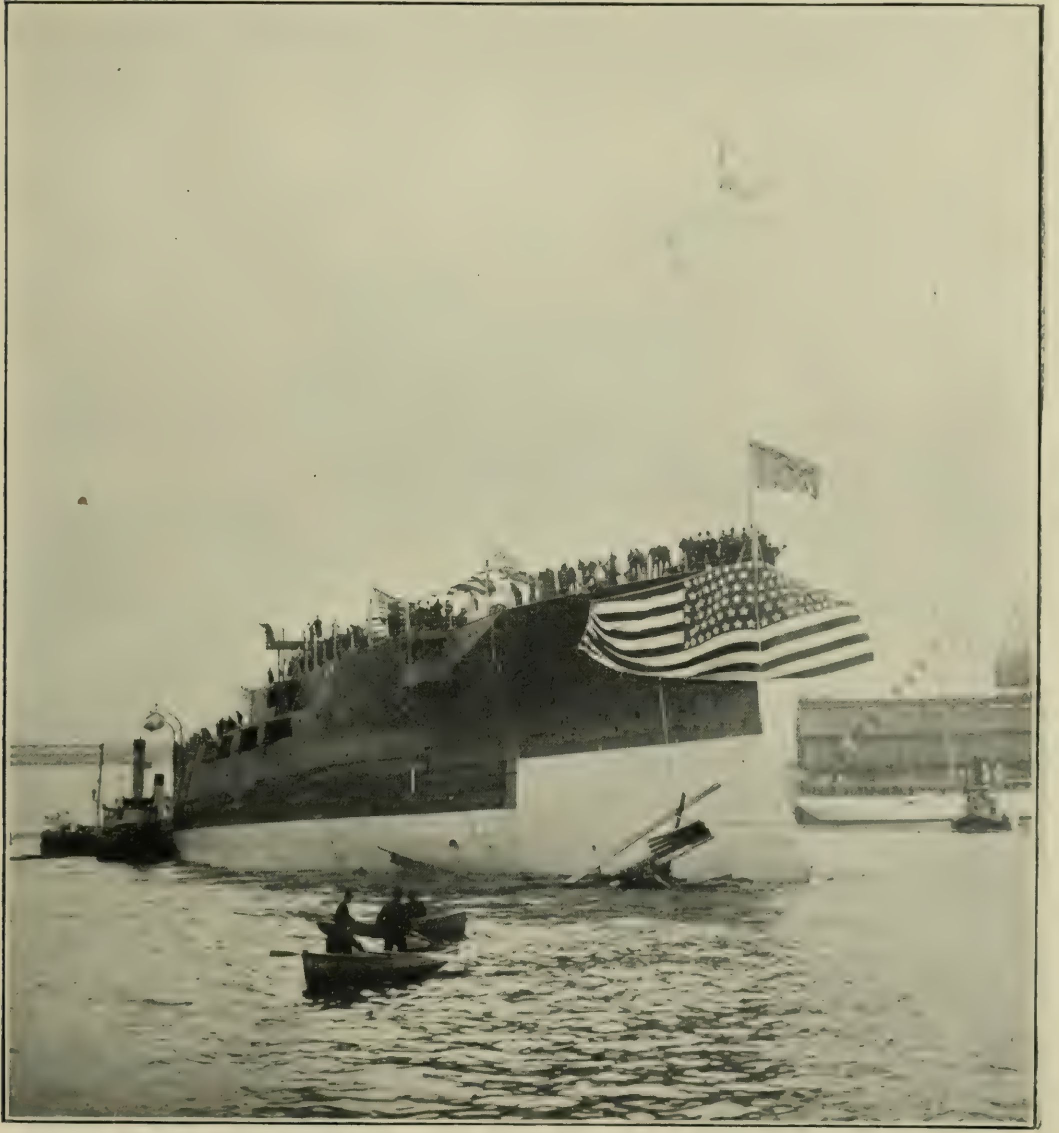
	Annual.	Dry months (3)	Rainy months (9)
Atlantic coast	0.114	0.228	0.100
Central district	0.141	0.185	0.122
Pacific coast	0.117	0.178	0.091
Averages	0.124	0.197	0.104

The general accordance between figures reached by so different methods is certainly striking; and the fact that the new measurements show that evaporation in the three comparatively dry months is nearly double that in the rainy season is a further confirmation of their accuracy, and incidentally of the value of the method of analysis by the use of the ratio between rainfall and outflow. It may be added that the latter when applied separately to the catchment basins above Gamboa and Bohio indicated a small escape by percolation under the dam site at the latter place, a fact confirmed by borings. Unfortunately the application of this method in temperate regions is rendered difficult by reason of complications introduced by ice and snow, and by the more irregular rainfall. In fine, on the Isthmus it may be considered as well established that of the total volume of the rainfall about one-third escapes directly through the beds of the streams, another third finally reaches the sea by the same channels as ground water, and the remainder returns to the atmosphere by evaporation.

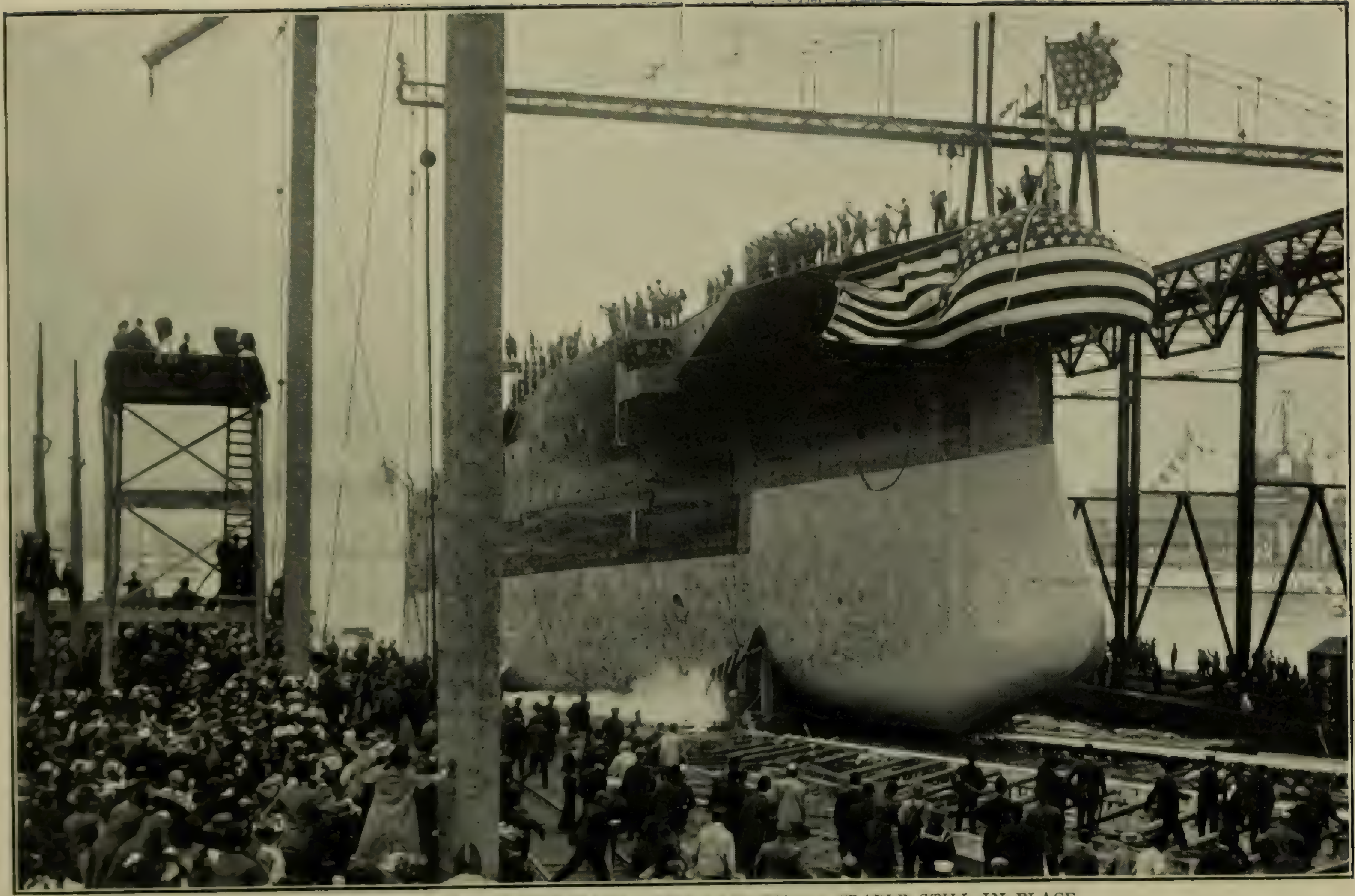
THE UNITED STATES BATTLESHIP FLORIDA.

LAUNCHING OF THE NEWEST AND LARGEST VESSEL IN THE U. S. NAVY.

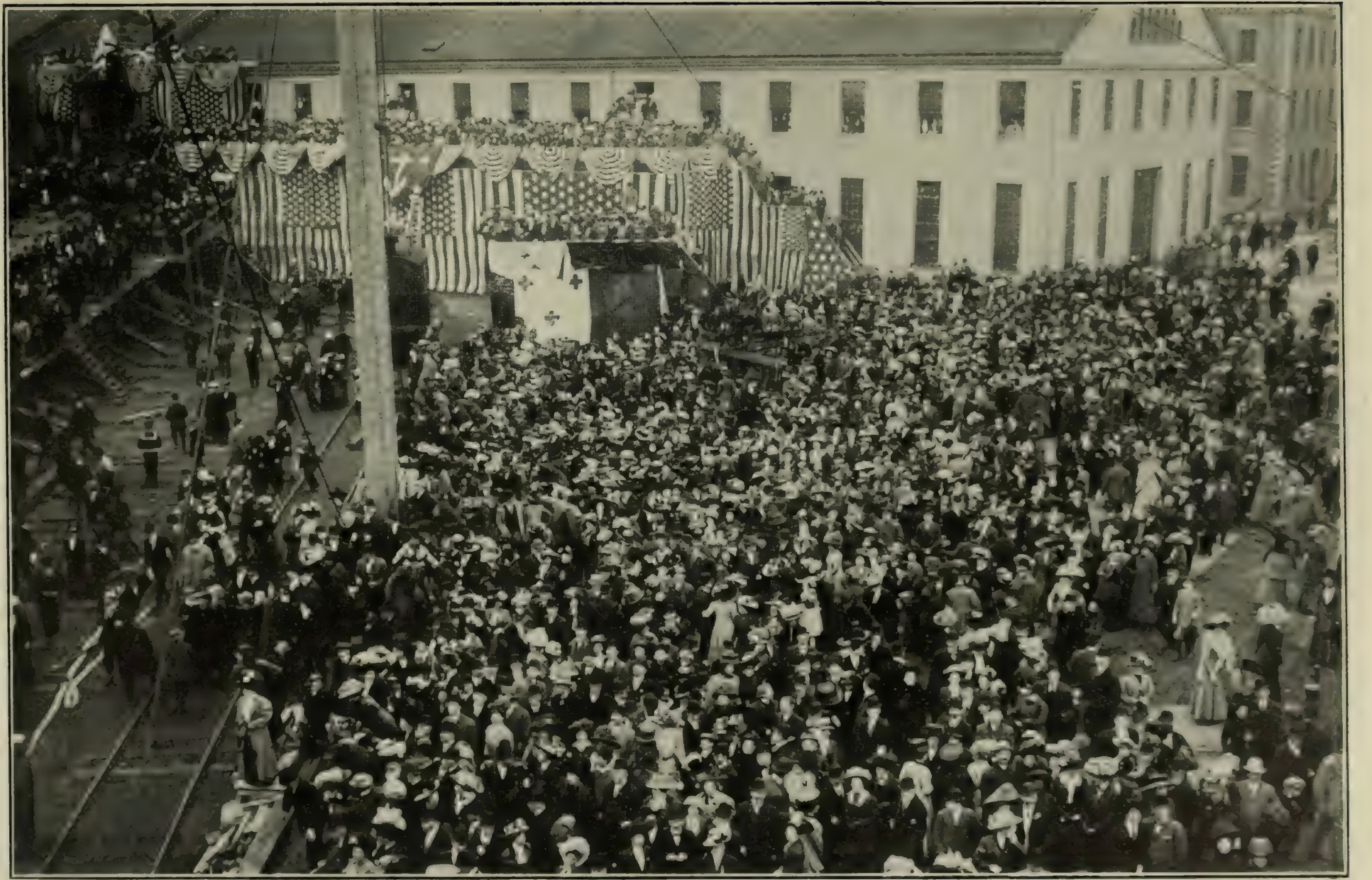
The pictures on the following pages illustrates some of the most interesting incidents at the launching of the Florida, which was "put overboard" at the New York Navy Yard on May 12 at 11.21 a. m. The ship is offered as the finest example of construction by the Navy Department itself. She is 521 feet 6 inches long, 88 feet 2½ inches beam, 28 feet 6 inches mean draft, 21,825 tons displacement. Her main battery is ten 12-inch, and sixteen 5-inch guns, her speed 18 knots. As launched, she was 68 per cent completed.



THE FLORIDA FAIRLY AFLOAT, IMMEDIATELY AFTER THE LAUNCH.
Parts of the launching cradle are afloat alongside. The tugs are just taking her in tow.
Photographed by Edwin Levick, N. Y.



JUST BEFORE LEAVING THE WAYS. THE LAUNCHING CRADLE STILL IN PLACE.
Photographed by Edwin Levick, N. Y.



THE CROWD BEGINNING TO BREAK UP AFTER THE LAUNCH.

The launching ways are on the extreme left, the sole pieces that were sawed off to release the ship being near the furthest stairway. The launching party were on the high platform in the left background. Photographed by Edwin Levick, N. Y.

ON THE LAUNCHING PLATFORM, BENEATH THE BOW OF THE FLORIDA.
Miss Fleming, the sponsor, is in the center of the picture. The bottle was swung by the flag-decked cord. Photographed by Edwin Levick, N. Y.

HUMIDIFIERS, THEIR PRINCIPLES AND USEFUL APPLICATIONS.

By Sterling H. Bunnell.

The theory and practice of humidification are to certain extent controversial. Mr. Bunnell's statement is made from the standpoint of the "Evaporative school," but the criticism of leading representatives of opposing schools has been invited and their suggestions, so far as practicable, have been incorporated. The purpose of THE ENGINEERING MAGAZINE is to foster interest in a subject of large importance to the efficiency of operation in many lines of manufacture—larger importance than is yet generally realized.—THE EDITORS.

THERE are many materials, operations, and products which require special atmospheric conditions for advantageous or profitable maintenance. Principal among such operations is the manufacture of textiles, perhaps the largest single industry carried on in factories. In the favored climate of the Lancashire and Bolton districts of England, the natural climate affords working conditions equalled in America only on occasional days in certain localities. Even in England, however, there are many days in which the atmosphere is too dry for the best work. Since textile fibres are increased in strength and elasticity by high humidity and moderately high temperature, breakages are less frequent under proper conditions, and the output is increased. But even before the fibre reaches the manufacturing plant, atmospheric humidity plays an important part. Cotton loses weight as it dries out; but more than that, the fibres bristle and appear shorter and of lower grade than when slightly moistened. Leather, feathers, and many other porous substances lose a considerable percentage of weight in drying out; so that the maintenance of average and uniform humidity in the storage rooms has a direct advantage to the owner in maintaining the value of his goods as they lie in the warehouse. Cigars and tobacco lose flavor in dry air, and regain it to some extent, after loss, by storage in properly humidified rooms. Wooden furniture, and musical instruments, are sometimes cracked or the finish injured, by the dry air of steam-heated rooms. All these and other similar goods are advantageously worked or stored in rooms in which the atmospheric humidity is artificially controlled and kept at the most desirable point.

Ideal conditions may be found naturally in certain favored locations or climates. In other places, they must be produced by artificial methods. Heating the air in the workroom to promote the comfort and health of the operators, and therefore to increase their output, is the original idea from which has sprung the modern system of providing extensively for comfort and even luxury in factories. Heating apparatus, however, provides against only one of five undesirable atmospheric conditions—deficiency in temperature. The others are excess of temperature, excess, or deficiency, of contained moisture, and the presence of foreign matter such as dust or deleterious gases. Temperature and humidity are inter-dependent, so that a change in one is likely to involve a change in the other; in many cases, apparatus must be provided to control both conditions simultaneously in order to provide the best working atmosphere.

There is a certain fixed quantity of water vapor that can be carried by a cubic foot of air at a given temperature and atmospheric pressure. This quantity increases with the temperature. Air carrying its full contents of moisture is said to be "saturated," for the injection of a further quantity of vapor will cause the condensation of an equal amount into cloud, fog, or mist, formed of minute drops of water suspended in the air. Heating the air thus over-saturated, which increases its capacity for moisture, will be followed by evaporation from the surfaces of the drops, until the mist disappears. With regard to its temperature, air saturated with moisture is said to be at the "dew-point," since the slightest fall of temperature will decrease its capacity for carrying water vapor, and be followed by the condensation of the excess upon the surfaces of solid objects. If the condensation takes place upon the dust particles floating in the air, mist appears. It is in this way that clouds and rain are formed in the upper atmosphere of the earth. Air which is saturated with vapor or "at the dew-point" is said to have a humidity of 100 per cent; with less than saturation, the ratio of the quantity of moisture present, to the total quantity which can be carried at the given temperature, is expressed in a percentage; thus air at say 60 degrees having half its possible quantity of moisture, is said to be at 50 per cent humidity.

Since the quantity of vapor required to saturate a cubic foot of air increases with the temperature, it follows that heating air, which increases its capacity for moisture while its contained moisture remains the same in quantity, will decrease the relative humidity. Similarly, decreasing the temperature of air containing moisture increases its relative humidity. Furnace or steam-heated air, being warmed without increasing its moisture content, is relatively dry, and increases the rate of evaporation from moist surfaces, as in drying kilns. Evaporation is increased to an undesirable extent in houses and offices, where wooden furniture is dried out and cracked, and human beings subjected to a surface-drying process which accentuates the effect of each temperature variation and increases the chances of "taking cold." Refrigerated air, on the other hand, becomes relatively more humid, and if the cooling process is carried through more than a few degrees, the air reaches the saturation point and the excess of moisture is deposited on the cooling pipes and all solid objects, or condensed as mist upon the dust particles.

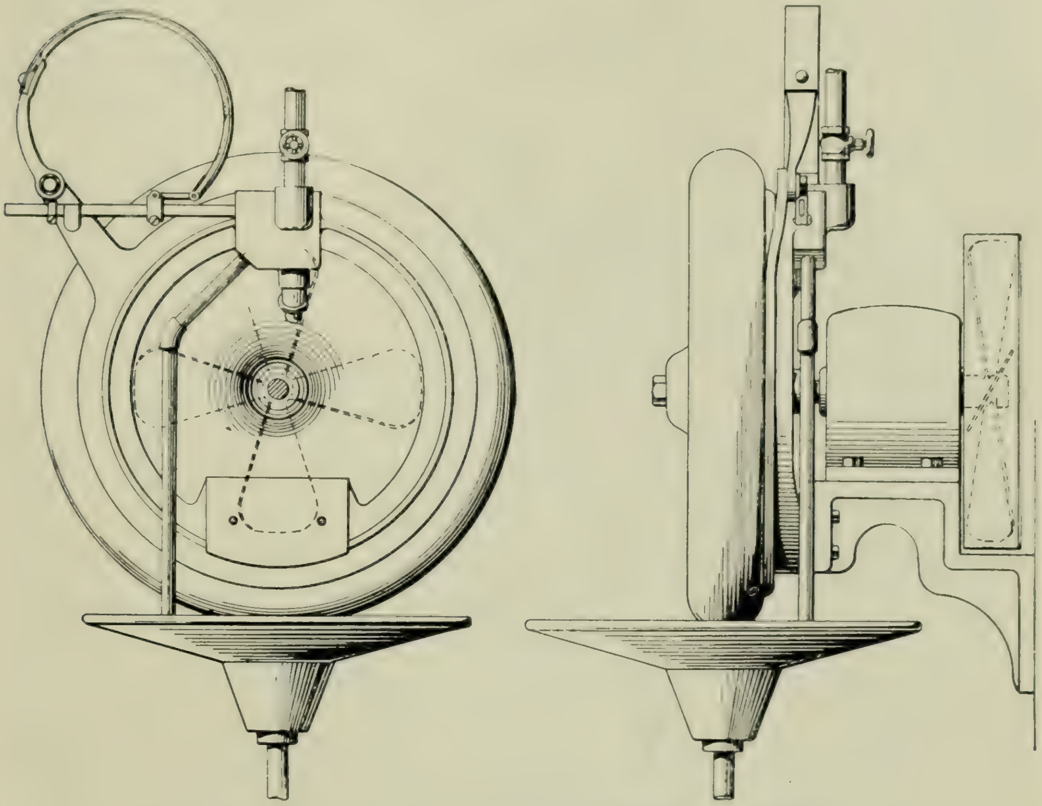
The principles governing the disappearance of heat in the evaporating process, the heat becoming latent in the vapor, and its corresponding reappearance in the process of condensation of vapor into liquid, are generally understood. It follows that a decrease in atmospheric temperature sufficient to reach the dew-point and cause condensation of vapor, will cause the liberation of latent heat tending to check the fall in temperature. Conversely, the injection of water sprays into the air for the purpose of increasing the humidity will cause the loss of sensible heat as the spray-drops evaporate. In every humidifying process, it is necessary to consider the effect of temperature, both in its relation to the actual evaporation of the moisture, and with regard to the alteration of relative humidity by subsequent changes in temperature.

The most obvious method of increasing atmospheric humidity in a factory or warehouse is by the direct admission of steam. The device used is of the simplest, consisting of a small valve, set by hand, and a receptacle to catch drip. As the water is already in the form of vapor, there is no latent-heat effect to be considered. Since the specific heat of steam is low, the heating effect on the air due to the cooling of the relatively small quantity of vapor is for many purposes unimportant. If, however, a humidifying process is to be used for workrooms in hot, dry weather, even a small increase of atmospheric temperature is intolerable. In textile mills, the use of "steam-pots" for humidifying, once approved practice, is today considered almost archaic. Rotting woodwork, wet and rusting machinery, uneven and fluctuating humidity, and discomfort and disease for the workers, have formed a strong combination to increase operating expense and decrease profits. The steam-pot will therefore eventually disappear from the few remaining mills using it, as soon as finances permit the purchase of modern equipment.

The next step in the development of humidifying apparatus produced the spray system, in which water is introduced into the atmosphere through some form of nozzle. Trade literature put forth by inventors and manufacturers of the older spray devices actually claimed the division of water into molecules by the mechanical effect of their marvelously efficient nozzles. This is obviously impossible; the most effective division by mechanical means can do no more than fill the air with tiny globules of water, each containing many millions of molecules. Such drops will float away in the air currents, evaporating gradually from their surfaces, until the envelope of air surrounding each drop is saturated so that evaporation ceases, or until the globule disappears. If the spray drops fall into air which is already near saturation, they cannot evaporate completely; and if they are carried into a cooler part of the room or against relatively cold objects, the process will reverse itself, and the drops will increase in size, until the fall or float into contact with machinery, fabrics, or whatever may be in their way, and form a coating of moisture.

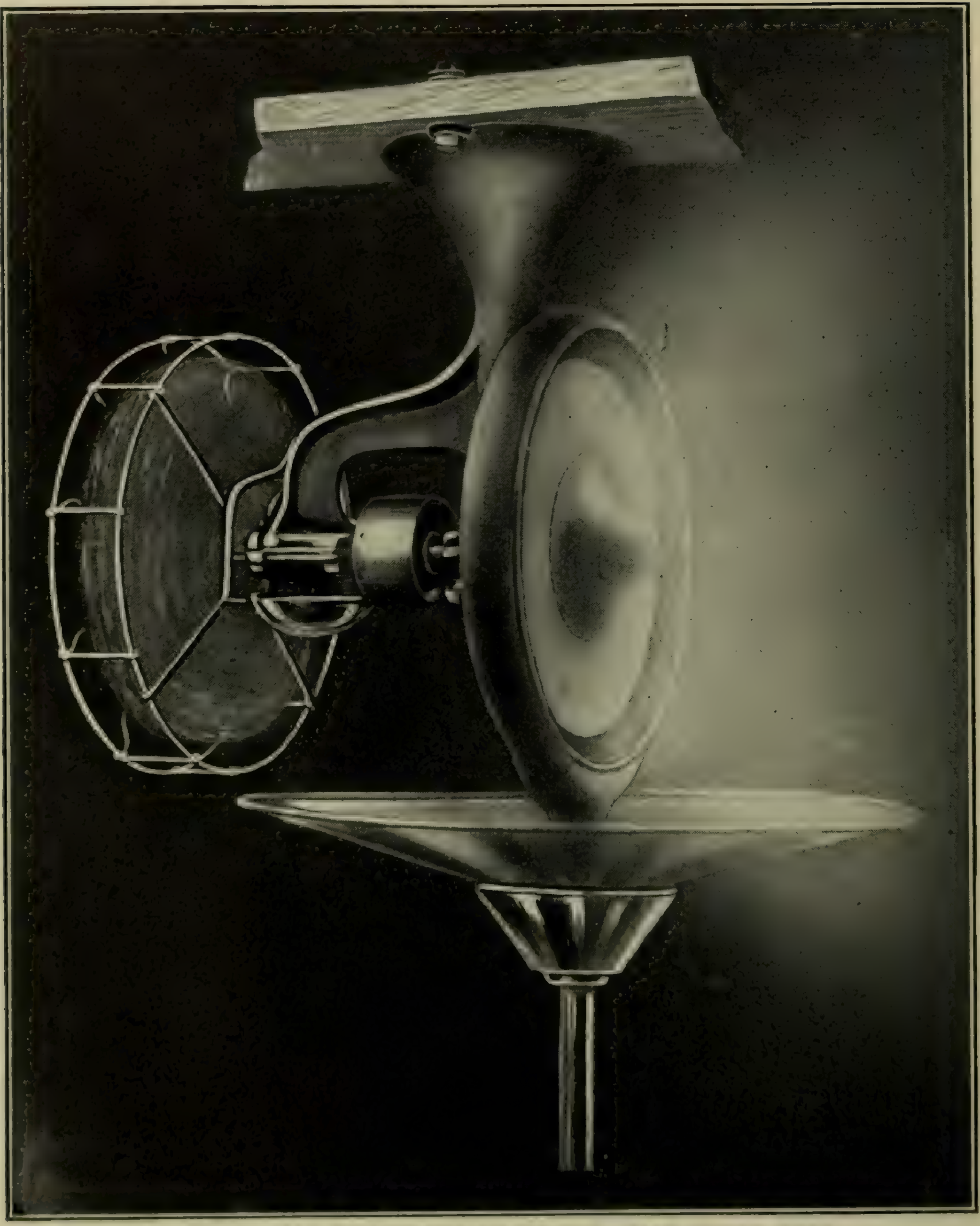
An important detail of any spray device is the water distributor or nozzle, the effectiveness of the system being proportional to the fineness of the spray. The water is forced to the nozzles under a pressure of 60 pounds or more, and discharged in opposing streams, or against suitable obstacles, tending to divide the streams into minute drops. The humidifying unit or "head" comprises a nozzle placed in the upper center of a cylindrical casing, through which a current of air is induced by the mechanical friction of the spray. As the air from the room is drawn into and through the casing, the floating dust and lint is washed out by the spray and carried into a drip pan and thence into the drainage system. Only a portion of the water pumped to the head is carried out by the air current and evaporated. The latest type of humidifier has a divided case, hinged so that one-half can be swung aside, exposing the whole interior and making it possible to clean the case thoroughly and quickly.

The chief fault of the simple spray humidifier is the lack of any positive means of circulating the air and floating spray. It is true that water, once vaporized, will diffuse itself rapidly (like a gas) throughout the room. This tends to equalize the variation in humidity between any two points in a room containing humidifiers spaced as in ordinary practice. As, however, evaporation is a comparatively slow process precedent to diffusion, the tendency is to produce uneven humidity, too great under and near each "head," and too little in the space between, though circulation is helped to some extent by the movements of belts and pulleys in the textile mill. Spray humidifiers have therefore been devised which provide for circulating the air by fans, or by air blasts. Representative of the first is the Tillotson humidifier, a cylindrical casing placed horizontally, open at the ends, and supplied with a disk fan at the inlet end of the case. Water is introduced by a central sprinkler pipe, and allowed to fall upon a revolving brush, which throws the drops off centrifugally into the air current. The interior of the cylindrical wall is provided with a lining of absorbent cloth, to catch the drops which succeed in passing clear across the air current, and prevent water from running down the interior of the casing. The intention is to povide a strong current of air and to fill the current with minute drops of water which are expected to float until evaporated.



SIDE AND FRONT ELEVATION, HYGROSSO HUMIDIFIER.
Showing the automatic regulator—a cross-sawed wooden ring responding very sensitively to hygrometric changes.

Another spray system using a forced air current to distribute the drops of water during the evaporating process, is the Hygrosso, manufactured by J. W. Fries of New York. This device is essentially a disc fan, driven by belt or electric motor, and blowing against a spray-forming device placed adjacent to the fan. The current of air traveling forward from the fan, passes through the spray and carries the drops forward in a straight line. The circulation induced by this device is brisk, and extends through a considerable distance from the

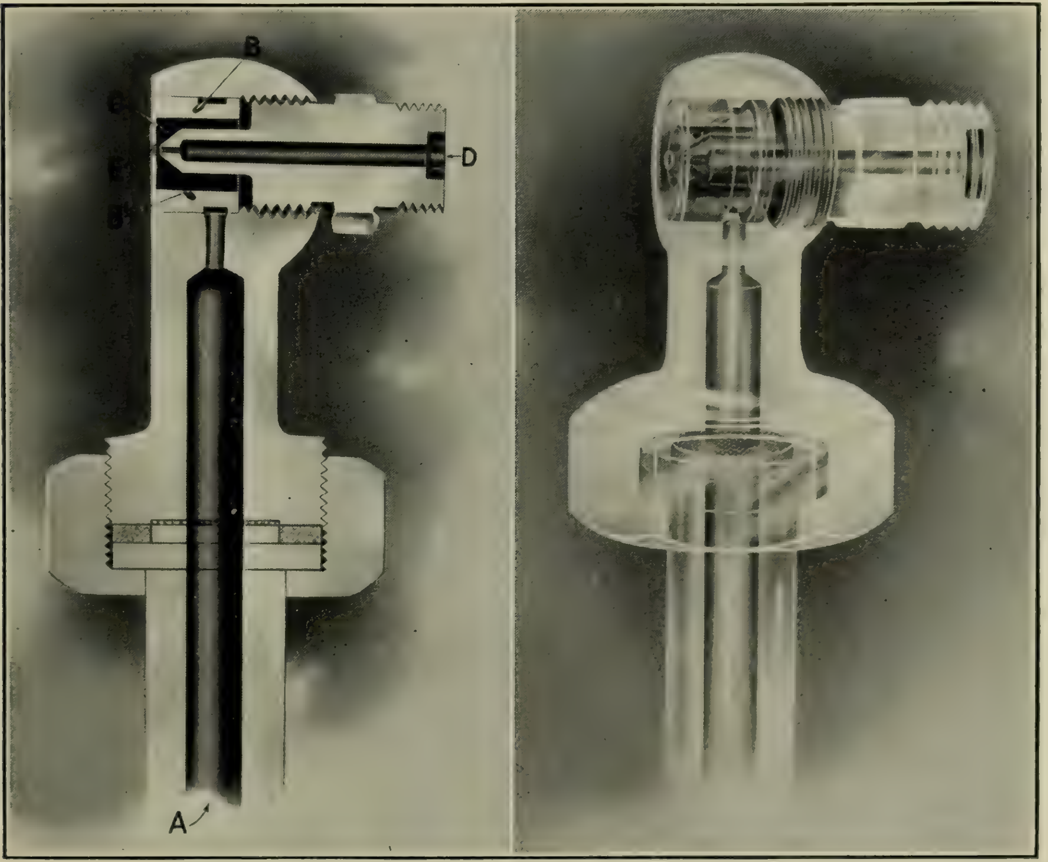


THE HYGROSSO HUMIDIFIER IN ACTION—BELT-DRIVEN TYPE.
John W. Fries, New York.

humidifier. It is a non-automatic spray, carrying forward into the air of the room all the water which is caught in the air current. The remainder is received in a pan provided for the purpose and is drained away. The forced air circulation ought to insure the evaporation of a much larger portion of the water passing through the machine than would be the case with spray humidifiers not so provided.

The system of providing circulation of spray-filled air by a direct blass of compressed air is represented by but one type, the Turbo-

Humidifier of Fitchburg, Mass. The Turbo takes its name from its nozzle, which is made with tangential ports like a turbine, through which steam or compressed air issues with a whirling motion. These jets mingle with a central stream of water, "atomizing" or spraying the latter, and forcing it cut in a fine conical mist. The details of the Turbo-Humidifier are very ingenious. As the nozzles are to be placed overhead at proper intervals, any drip would fall on machines and materials below and be most objectionable. The water supply is therefore governed by a single float tank, so that the water level is an inch or more below the opening of the nozzle. The jets of air or steam act to cause enough of a vacuum to lift the water to the outlet, while any failure of the jets leaves the water to drop back to its gravity level instead of dripping on the floor below. A single tank and float controls the water supply to all the humidifying nozzles on an entire floor of the mill. The quantity of water delivered by each head is controlled by an adjustment which regulates the position of an axial water inlet, and a shut-off valve is provided with a long balanced lever with eyes at the ends, adapted to be easily opearted from the floor by a hook or stick in the hands of a workman. To pro-



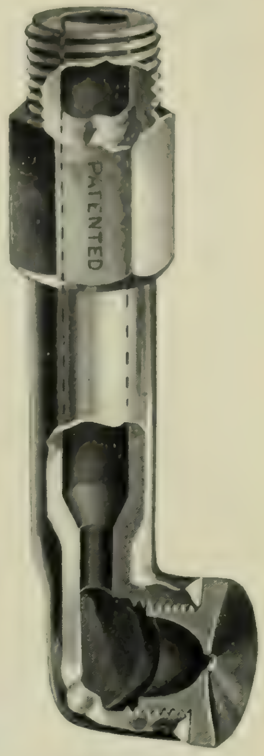
THE TURBO-HUMIDIFIER; SECTIONAL AND "GHOST" VIEW.
G. M. Parks Co., Fitchburg, Mass.

vide for ready inspection and cleaning when required, the nozzles are attached by simple union joints, so that they can be removed at a moment's notice.

With any spray system, any desired quantity of water can be put into the air of a factory or warehouse. But the only means of determining how much is desired is by careful and constant observation of the humidity by means of wet and dry bulb thermometers, and the necessary tables. The water discharged into the air must either evaporate or wet the surface of the objects in the room. It will be too much or too little according to the chance setting of the spray valves though the tendency is to maintain equilibrium so long as moisture supply, temperature, and rate of air change are constant. Only constant watching can provide even a fair approximation to uniform humidity in a large room served by spray "heads." Further, uncertain circulation of air containing floating drops of moisture may disturb the thermometer readings so that they may indicate deficient humidity, when in fact there is so much free mist that operating conditions are very bad. To provide automatically for maintaining a proper humidity, it has been attempted to regulate the operation of the system mechanically or electrically.

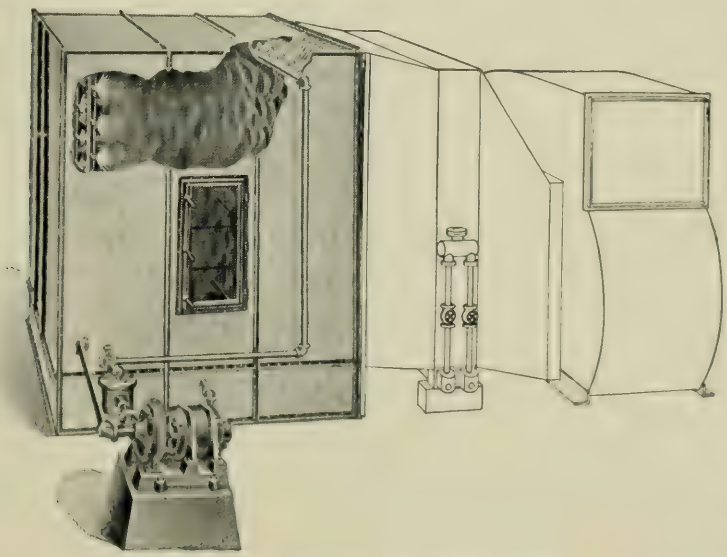
A spray system providing automatic regulation is that of Stuart M. Cramer, of Charlotte, N. C. The humidifiers of this system are of shape similar to the American, but have motor-driven fans at the top to provide positive downward circulation. Certain of the units installed in the mill are connected with the outside air, providing for an influx of air for ventilation; while the rest are spaced about the room and allowed to keep the interior air moving. The controllers depend on the principle of the wet- and dry-bulb thermometer and the fans start or stop according to the humidity of the air. The Cramer humidifier, therefore, takes note of the shortcomings of unregulated spray systems, and provides means intended to equalize conditions independently of human watchfulness.

The spray systems thus far described comprise a multiplicity of small "heads" or units, each intended to operate within a limited area. There are two systems, however, which represent the modern idea of concentration of effort in a central plant. One of these is the Osborne system of the Griscom-Spencer Company, of New York. This apparatus provides for heating and humidifying large buildings by the blower system. A slow-speed steel-plate fan draws air either from the mill, or from outdoors, or in part from each, and forces it over steam-heating pipes, and thence into a spray chamber, where it passes through a shower of water. The air next passes into a cen-

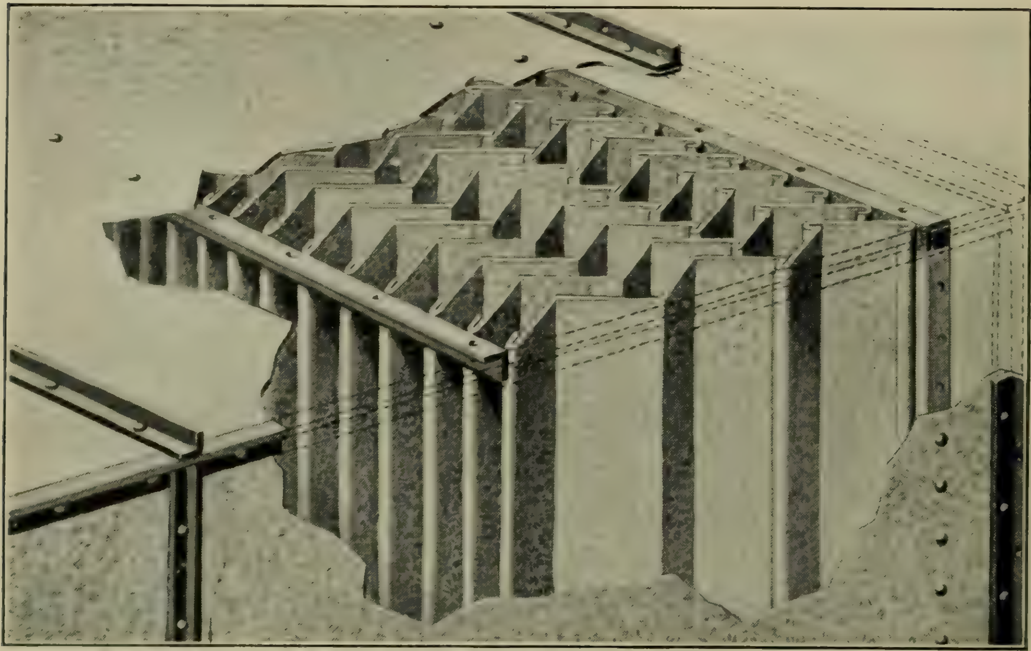


CARRIER SPRAY NOZZLE.

trifugal separating chamber, where the entrained drops of water are thrown out; and thence into the ventilating ducts of the mill, to be distributed through properly spaced openings. The apparatus is simple and efficient, and economical in operation. The other system is that of the Carrier Air-Conditioning Company, of New York. This apparatus is the reverse of the above, as the air is first drawn through a spray chamber where it is saturated, and then passed through the eliminator plates where all the excess water is removed, thus causing the air to leave the humidifier at the dew point or saturated temperature. The temperature of the dew point is automatically controlled by means of a thermostat which operates the dampers, controlling the air supply so that the air comes in either from outdoors or is returned from the mill, as may be required. Controlling the temperature of saturation thus fixes the number of grains of moisture carried by each cubic foot of air. The air upon leaving the humidifier is either passed through the heating coils or by-passed around them, as may be required by the mill, after which it enters the fan and is blown through the ducts into the building. The air passing through the spray chamber in summer time, on account of the latent heat of evaporation is cooled to the entering wet-bulb temperature. This means that the drop in temperature during hot weather is from 15 degrees to 18 degrees, and the air is delivered into the mill in sufficient quantities to absorb all the heat produced by the friction of the machinery, thus holding the air temperature in the mill down in summer, and at



CARRIER HUMIDIFIER IN OPERATION.

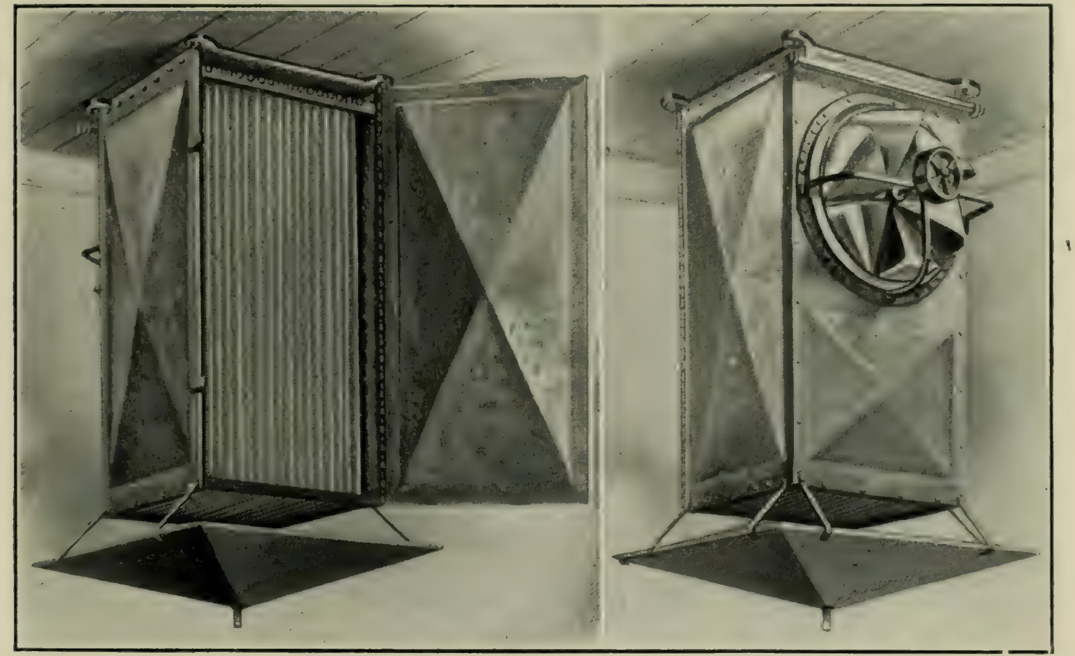


ELIMINATOR PLATES FOR REMOVING EXCESS WATER, CARRIER SYSTEM.

the same time maintaining the relative humidities desired. The Carrier system has an ingenious regulator operated on the dew-point and dry-bulb principle, maintaining a constant difference in the temperature of the saturated air leaving the humidifier and the temperatures of the room. This regulator accomplishes this result by opening or closing the dampers in the rooms, allowing more or less air, as may be required, for holding the room temperature in the proper relation to the saturated temperature, thus maintaining both a temperature and relative humidity regulation at the same time. It would thus seem that the regulation depends for its effectiveness entirely upon the difference in expansion due to the two temperatures.

As has been said, the common feature of all spray systems is the absence of any essential relation between the quantity of water thrown into the air, and the quantity of vapor required to supply the deficiency which actually exists at the moment. There is a very simple and positive natural law which provides the basis for a system in itself automatic and self-regulating—the law limiting the rate of evaporation into moist air. As previously explained, into saturated air there can be no evaporation of moisture. In dry air, evaporation from the surface of a liquid is rapid. As the relative humidity is increased by the accumulation of vapor, the rate of evaporation decreases, until at the dew point the balance is established and no more vapor can be formed. In moving air, evaporation is more rapid than in still air, but ceases at the dew point in any case. If, therefore, a suitable area of moist surface is provided, and an air current of proper velocity passed over it, the relative humidity of the air will be built up near to the dew point, and will then cease to increase. No regulating device will be necessary, as evaporation will cease as the air becomes moist, and commence again when the air becomes dryer. This is the principle of the evaporative humidifier originally invented by Dr. Louis Bell of Boston, and also of the Benz humidifier.

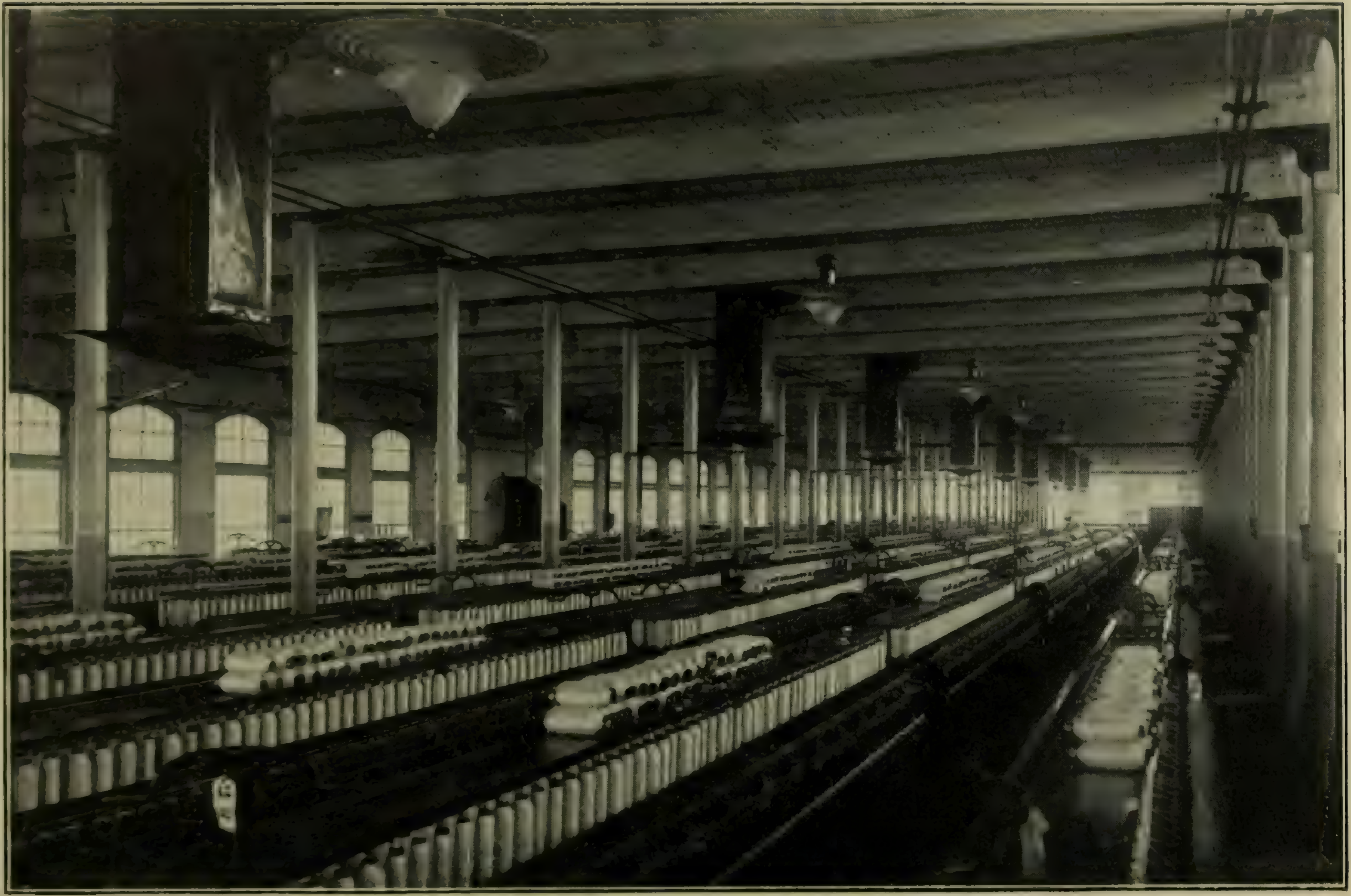
The Benz apparatus consists of a chamber containing water, through which air is forced by a fan. The agitation of the water and its contact with the air current facilitates evaporation and increase of the relative humidity of the air. It is impossible to prevent the entrainment of moisture in the air current and its passage out of the humidifier in the form of floating mist. The travel of the air current in contact with the water is very short, so that it seems probable that the humidifying effect will be limited.



BELL HUMIDIFIER WITH DOOR OPEN.

BELL HUMIDIFIER, SHOWING FAN.

The Bell Humidifier, as made by the Griscom-Spencer Company, of New York, consists of a rectangular copper case containing suitable sheets of moistened cloth. Each cloth is hemmed at its upper and lower edges, the upper hem being slipped over a slotted brass pipe, and the lower end held down by a rod by which the cloth is stretched in position with sufficient tension to keep its place. The spaces between the sheets are equal, about one inch in width. A fan 18 inches in diameter, of the disc type, is secured to one side of the casing at the extreme top. By means of this fan, air from the mill room is drawn into the humidifier casing and forced down between the sheets of cloth, emerging from the bottom of the case, where it



SPINNING ROOM OF TEXTILE MILL EQUIPPED WITH BELL HUMIDIFIERS.

is deflected evenly on all sides of the machine by a drip pan a short distance below the casing. The fans of the humidifiers are driven either by independent electric motors, or by light belts, or by a group drive from a motor of suitable horse power.

Water is supplied to the humidifier (either from city mains or from a float tank under low pressure) by the small manifold pipe to which the slotted pipes supporting the cloths or mantles are connected.

Under all conditions the uniform speed of the air through the narrow spaces induces the evaporation of moisture to a maximum which depends upon the cubic feet of space supplied by each humidifier.

Objection has been made to the Bell mantles as harboring dirt and disease-germs. Impurities, however, are better out of the air than floating in it; and once in contact with wet surfaces, they are permanently retained. Bacteria, having no means of locomotion, and being millions of times larger than the molecules of water, cannot escape from wet surfaces by any process of evaporation. As the sheets are never dry, the particles cannot escape as dust; so that the elimination of floating impurities is effective and final. When the layers of collected particles become sensibly thick, the cloths may be substituted by a fresh set, and the soiled ones removed and washed and later used again.

The spray humidifier is obviously the quickest in operation, and where a possible excess of moisture is not objectionable, and great uniformity is not essential, it has the advantage. The compressed air spray has an accessory advantage in its adaptability for use with air-blast hose and nozzles for cleaning machinery. The central-plant, forced-ventilation systems do away with extensive pipe systems, and distribute properly conditioned air to all parts of the factory, with the well known advantages of such systems when used for heating purposes only. The evaporative humidifier is automatically self-regulating, tending to build up the atmospheric humidity to a constant level governed by the fixed speed of the air propelled by the fan. It has also the advantage of being independent of a central pumping plant or air-compressor, each head being self-contained, even to the extent of lifting its own water to flush its cloths, by a small auxiliary pump driven from the fan shaft.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

II. THE HANDLING OF STORES AND PREVENTION OF WASTE.

Mr. Claydon's articles are not addressed to the highly organized and amply officered foundry characteristic of a few of the latest and most advanced establishments, but to the modest plant which needs to study carefully the outlay of every dollar and the sufficiency of the returns secured. His argument is that the very practical, common-sense and simple records he advocates will much more than repay the small cost needed to put them into effect. His third article, in July, will discuss "Keeping Down Shop Expenses."—The Editors.

IN all probability there is no business in which the opportunities for waste are so numerous as the foundry. The very nature of the materials used seems inseparable from waste, and for this reason many foundrymen do not even attempt to keep track of the various stores that enter into the production of castings and the maintenance of the plant. It would not be an exaggeration to say that many men are losing thousands of dollars in the course of a year through careless methods in handling this part of their business. I had a talk recently with a foundryman, in no small way of business either, and this subject was under discussion. When asked why he did not keep track of his stores, he replied that it was too much trouble, and would necessitate the employment of extra clerical hands. Moreover, he went on to say, his business was to sell his goods and make money. Here we have the point at issue, viz:—Are we making money if we do not know actually what our castings are costing us?

In order to facilitate matters I intend in this article to take the individual shops that make up the plant, and to deal with the main stores kept in each, endeavoring to show a method of handling them which I trust will be of service and will enable any manager to bring loss and leakage down to a minimum.

First of all, then, we must consider the foundry; and obviously the stores that first come to our mind are the elements that go to make up our cast—such as pig iron, coke, coal, limestone, etc. With such items as these it might reasonably be wondered whether it is possible to keep at all accurate records of the consumption. I suggest that we can do so, and in the following way: All invoices covering these materials should be handed to the stores clerk, who will enter up on cards the amounts received from time to time. Upon the receipts of these heavy materials, it is wise I think, especially with pig iron, and if your yard space will allow, to keep this in separate car-load lots, and at the top of each pile a stick should be placed bearing the car number, as in this way we facilitate very much the taking of stock, which it is essential that we do fairly frequently.

We will now consider the use of these materials by the Foundry. At the proper time, the man in charge of the cupola charging floor is given his iron mixture, and the probable weight of the day's cast. He will now have his men bring up to the charging floor on separate trucks the different materials in the proper apportioned quantities that go to make up each charge. For example, one charge might be composed of the following:—1,000 pounds Hamilton iron; 1,000 pounds Scotch pig; 1,500 pounds foundry scrap, and 800 pounds machinery scrap, all this of course being weighed over the cupola scales. As each of these charges is put into the cupola, the man whose duty it is will enter up on a form provided for the purpose these separate weights, so that at the end of the day we have a correct record of what made up our cast. In precisely the same way he will keep track of the limestone, etc., so that with ordinary care one should obtain accurate results. This cupola report should then be turned over to the stores clerk, who will enter up on the cards before mentioned the weights of each of these different materials used; then by merely subtracting the disbursements from the receipts, we have at a glance our stock on hand, which is surely of great value to us. It prevents the possibility of running short and enables us to advise the purchasing agent as to the stock in hand and helps him in governing his receipts. Still more important, it gives us the basis for our costs, as at the end of the month we add up the different quantities used and charge them out at their price, and thus find out what our metal is costing us per 100 pounds good castings. This is a piece of information no foundryman can afford to lack.

Whilst dealing with the foundry it would be advisable perhaps to consider our foundry scrap—in other words, our sprues, gates and bad castings. Here is an item which is often very carelessly handled, this carelessness invariably resulting in one of our biggest sources of waste. It is essential that the sprues, etc., be carefully cleaned up from the foundry floor every day, and their correct weight ascertained, as obviously they return to the cupola for remelt, and the cost of our metal will in no way be correct unless our foundry is given credit for the weight and value of its scrap. An interesting point, which was argued recently, might very well be set down here:—at what price should this remelt be charged? There is no doubt in my own mind that the following way is the fairest method of dealing with this—presuming we use two kinds of pig iron, one at $20 per ton, the other at $18 per ton, and machinery scrap at $15, the remelt should be charged at the average price of the bought materials, so that in this case it would be $17.66 per ton. Another point worthy of consideration is, should the iron, etc., be charged out at the bare invoiced price, or should freight and unloading charges be included—that is, should we take the cost of our iron, as ready to be put into the cupola? To a certain extent this must be governed by the cost system in force, but I think it is wiser to charge these at their value to us ready for use, otherwise freight and unloading charges must go through the foundry burden, in my opinion unnecessarily swelling it. It is always the better plan to keep our burdens as low as possible.

We will now consider our moulding and core-shop supplies; the principal of which is, of course, sand—perhaps one of the most difficult things to keep track of at all accurately. A system similar to the following is about the best I know of. In convenient proximity to our sand piles, pads should be nailed up and every time an employee brings out a wheelbarrow load he should make a mark on the pad. At the end of the day the sheets with these marks on should be turned in to the foundry clerk, who would know the approximate weight of a barrow load and by totalling up the number of marks made would be able to record on his report the daily quantity of the sand used in the several shops. Facings and oil, etc., may be treated in much the same way, and when these various reports reach the stores clerk he should deal with them as explained previously. In addition to the items mentioned there are of course the small stores used in the foundry and core shops which I will deal with later on in this paper.

From here we pass along to the machine shop, and here perhaps we have the greatest difficulty on account of the numerous stores that have to be kept in connection with it. In all probability in conjunction with our machine shop we have our blacksmith's department, and obviously there is our wrought iron to be dealt with. It may not always be possible, but where it can be done this iron should be kept in racks according to the different sizes, each rack being labeled according to the size contained therein. The blacksmith on using any of this iron would of course enter up the quantity used on his time card, at the same time giving the nature of the job on which the iron was used. In this way our stores clerk can enter up periodically (daily if necessary) the quantities used in this department. In the machine shop generally most of our small stores are used, such as nuts, bolts, etc. These should be under the control of a general storekeeper, and such goods issued only on a requisition being sent in to him by the foreman of the shop requiring them. Such requisitions should state also on what work they are to be used, as only in this way can we apportion our material burdens to their proper shops and location. It should also be distinctly understood that nothing can be given out by this storekeeper except on the duly authorised form; it is only by the strict enforcement of this rule that we can ever hope to keep or receive accurate records. In the article that appeared in last month's issue I hinted at the possibility of our metal pattern department becoming our graveyard with regard to the time expended on patterns; so in the same way it will be with the stores used here, unless strict surveillance is kept on everything. Obviously steel forms an important part in this shop. This can be dealt with in much the same way as our wrought iron in the blacksmith's shop, but as this is a far more expensive item I would advocate at least our high-speed steel being kept under lock and key, and issued only in such lengths as are required for the particular job on which it is to be used.

Passing from the machine shop we come to our wood pattern department, and here we are confronted with the lumber used therein. Much the same methods prevail here as with our iron and steel, but we must not fail to take into consideration the fact that an enormous amount of waste occurs here, as for example in odd lengths of lumber, left over from jobs, which are of no avail for others; therefor the important thing to remember is that when taking lumber to be used on a job we must charge out the quantity actually taken, otherwise we shall be the losers; the reason is self-explanatory.

Before proceeding to the clerical end of the stores we must take a glance into our general stores. Here we have those hundred and one different articles, insignificant in themselves, perhaps, yet which if not properly looked after may cause a considerable loss of money. It may happen—nay, it has happened—that a man will go to the storekeeper for a box of screws without an order, and the storekeeper lets him have them, thinking that it was only a matter of a few cents; yet if he does this with one he will do it with another, and his laxity will mean inaccuracy in our costs. There is an old proverb which might well be applied in this connection "Take care of the pence and the pounds will take care of themselves." Let our storekeeper then see that nothing goes out except on a written authorisation, and our chance of waste will surely be minimised.

Having so far dealt with the arrangement and handling of the stores through the various shops, our next step must be to see their use in the office. We are often confronted with the remark that costing involves too much of the proverbial "red tape" or "paper work" and I am inclined to think that in some senses of the words this is only too true. One will often see an elaborate system carried on as far as the office end is concerned, while the departmental part of the work (which is probably even more important) is left pretty much to itself. In short, as long as the office receives a monthly record of the materials used in the shops everything is O. K., no trouble being taken to verify the statements so sent in. Surely this is "putting the cart before the horse." Undoubtedly, the correct method of handling our stores in the shops should be our primary consideration. Unless this is done the result is self-evident, viz., the official returns are not worth the paper they are written on, and our costs are absolutely no good to us; in fact, they are more harmful than otherwise. In too many of our foundries this fact is only too plainly manifested. Efficient stores management is one of the keynotes of good business. Provided, then, that we can rely upon our records, (and I am sure there is no reason why we should not) we have something that is indeed worth while for our trouble.

In dealing with the office end of the work then let us first think of our invoices. After these have all been O. K.'d by the purchasing agent, the stores clerk will enter them up under the separate articles designated in his stock material ledger, taking care (as in the case of pig iron and suchlike materials) to see that the freight and unloading charges are added to the invoice cost. After all the requisitions on the storekeeper and reports from the different shops for materials used for the month are in, he will proceed to credit his stores with the various items, at the same time charging them out again (in the distribution columns provided in his ledger) to the various accounts to which they are chargeable, as designated on the requisition forms.

Dealing with your receipts and disbursements in this way serves a twofold purpose. First, it serves as a perpetual inventory of goods on hand, as at the end of the month this ledger should be balanced and the totals brought forward to the next month. If this idea is properly carried out we have a reliable inventory. This in itself is of undoubted value, as in the case of fire destroying our works we can ascertain from these records the value of our stock on hand.

Second, by charging the stores out to the specific jobs on which they were used, the clerk can at the same time make out his shop-material burden reports (much in the same manner as the pay-roll burden form shown in my previous paper) and thus find out exactly what each shop has cost for stores used in manufacture and shop expenses. The value of this information is surely incalculable, as it shows up at a glance any undue expenditure on the part of any one or all of the shops; also, it enables the employer to find out the cause of the outlay and to know the why and wherefor for every charge made, thus preventing a repetition. Again, when a foreman is made to understand that his shop is going to be charged with everything used in it, he is naturally on his guard to see that his men waste nothing and that proper charges are made on all his requisitions; so that one can almost be certain that any orders issued will only be those that are absolutely necessary. You may depend upon it, no foreman wants his employer to come to him at the end of a month and tell him that his department is costing more than it should; and I believe that if this were done the foreman themselves would appreciate the knowledge to find out some way of further lowering their expenses, but this I hope to take up in a subsequent paper.

There is one other benefit derived from a systematic handling of our stores which must not escape notice. It is, I think, a recognised fact that in every establishment of any magnitude a considerable amount of pilfering goes on which it takes all one's time to detect, let alone put a stop to; but I suggest that under the system here outlined, where a man has to have a written order for everything signed by his foreman, the chances of his getting something for himself are reduced to a minimum, if not entirely done away with.

It may appear that taken individually the advantages accruing from such a method of handling our stores are not very great; but, when taken together, at least they certainly prevent waste,—which, as I have already mentioned, is only too often at the root of our high cost of production—and as our aim in view of keen competition is to get our costs as low as possible, it behooves us to see that we use every legitimate means at our disposal to secure this result, bearing in mind the fact that the clerical work required for the carrying out of this work is repaid over and over again by the prevention of such a great leakage as will exist when a careless method of handling our stores is persisted in.

The next article will consider practical means for "Keeping Shop Expenses down."

EDITORIAL COMMENT

The Principles of Efficiency.

HARRINGTON EMERSON'S earlier articles, which were published in THE ENGINEERING MAGAZINE July, 1908, to March, 1909, and afterwards issued in book form, were essentially the statement of a philosophy—a philosophy so fine and so hopeful as to merit the designation we then gave it of a gospel.

The studies begun in this issue, even stronger in demonstration and more specific in statement, are a reduction of ideals to practice. Mr. Emerson has formulated the requirements of any achievement as being: first, imagination—the single and definite idea of something to be done; second, principles, several or many, by which the doing must be guided; third, methods, still more numerous, for the expression of each principle; fourth, devices, which may be innumerable for the execution of any method. Methods and devices are usually standard. Imaginations are inspired. Principles are derived from correct interpretation of the laws of the universe. The series begun this month performs the invaluable service of defining the principles by which the great concept of Efficiency is realized.

In the introductory article leading this number, Mr. Emerson shows the successful working of these principles in historic examples. The next part will take up the organization necessary for their application in industrial undertakings. Following numbers will define and discuss the twelve principles separately and successively.

The appearance of such a teaching is peculiarly opportune, for the toll laid upon the nation by extravagance and waste due to inefficiency is growing too heavy to be borne, and the resistance to it is causing a great awakening of inquiry and effort toward relief. The vicious cycle so strikingly described by Mr. Gantt in the opening paragraphs of his article in this number has been too often repeated. We have gone too far in devoting our keenest thought, our best talent, our largest energy, our shrewdest personnel, to making and raising prices—to marketing our wastes with our product, our chaff with our wheat. With striking identity of vision, two great industrial philosophers—Emerson and Gantt—announce like conclusions. With individual differences of method they apply similar principles. And this issue of THE ENGINEERING MAGAZINE which presents Gantt's valedictory with regret that it *is* a valedictory, welcomes Emerson's salutatory in another preachment of the great promise of efficiency.

Insurance of Workmen.

IN a problem like that of insuring workmen against accidents or injuries incident to their occupation, there are so many forces and influences at play that theoretical deductions must yield to experimental results. Whether employers would be less careful to surround their men with safeguards when all accidents were paid for from a general fund; whether men would be more careless when they knew loss of life or limb would bring prompt compensation to themselves or their next of kin—these points are conjectural and controversial. The total result of ten years' experience in Germany is substantial fact. One such well-tested demonstration is better than many predictions and much argument; and for this reason Mr. Dawson's earnest advocacy of the German system of employers'-liability insurance (reviewed on page 411 of this issue) comes into court with its case more than half proven.

It is clearly to be read in the signs of the times that something directed to similar results will be attempted before long by American legislatures. The whole trend of economic thought and regulation points that way. The wise policy for manufacturers is to lead public opinion to the best solution—not to be forced to accept any measures wherewith excited sentiment might override their resistance.

Insurance, of course, is simply a means for spreading loss over so broad a foundation that it can be borne without sensible distress. The companies do not pay the losses; they are merely vehicles whereby the contributions of the real loss payers (the men untouched by death or fire or accident) are passed over to the losers, at more or less expense for administration and with more or less profit to the agents who manage the business. Incidentally, the so-called "insurers"—the real intermediaries—scrutinize every risk, study intelligently the causes of loss, and by reduction of preventable waste among the many, do even more good than by reimbursement of the occasional sufferer.

Thus, everywhere, insurance is found a beneficent institution, not only mitigating individual misfortune, but effecting a great total saving in the world of finance, commerce and industry—saving, further, the social organization from the demoralizing shocks of isolated individual disaster. If we do not see the advantage and the necessity for a similar protection of the exposed human units of our great productive army, it is simply because our eyes are yet darkened. But the loss of the thousands and tens of thousands maimed and killed in our mines, in our manufacturing plants, our railways, falls on the nation—every penny of it, with interest and multiplied by the inefficiency of our ill-ordered and unfit measures for meeting it. Well-devised labor insurance systems would be the replacement of the ways of barbarism by an effective civilized institution.

Concerning Technical Education.

A VERY interesting editorial in the *Scientific American* of May 7, entitled "The Decline of the University in Scientific Research," points out that the establishment of amply endowed special institutions offers to scientific men of a certain type, in enlarged measure and in more attractive form, the sort of opportunity formerly found only in the professor's chair. As a result, the colleges of the United States are losing, and to an increasing degree are likely to lose, the type of men who heretofore have given them much of their professional standing.

The writer of the editorial understates, if anything, the difficulties imposed upon university work by the growth in size and in number of students, which, unfortunately, is generally regarded as desirable by college authorities today—unfortunately, that is, so long as it is not accompanied by equivalent evolution of methods. It is impossible for the professor to maintain the personal contact with his students that, with smaller classes and with great teachers, made a college education in the best sense. Mark Hopkins on one end of the log was a vital force; but when the log becomes the trunk of a giant redwood, crowded to its farthest end with thronging students, the radius of even Mark Hopkins' influence is too short.

It is asking too much in proportion to the reward when we require in our university teachers a combination of high scientific attainments, strong personality, influential character, diplomatic tact, pedagogic skill, expertness in organization, high administrative ability, enormous endurance of hard work, and tolerance of the exactions of vast and intricate detail. The minor functions and the bounds and burdens of organization are perhaps most irksome to the largest minds.

The inevitable result is the retirement of many men the university should most desire to retain. The endowed laboratory appeals to some. The great corporations (which already are supplementing the college training of their junior personnel, and in some cases are on the point of supplanting it by institutions of their own) are absorbing and in increasing degree may absorb others.

That college and university education —especially in applied science—is reaching a critical point, is perhaps more apparent to those whose contact with it is external than to those whose contact is internal. By a critical point is not meant a peril to existence or continuity, but the more limited signification of a change in direction or character. What this change should be is worthy the most earnest study of the greatest educators. Generally it would seem that it must be akin to that which is so imperatively necessary in our utilitarian activities, in agriculture and industry: that is, it should be toward *intensive* and away from *extensive* effort. It should tend toward greater differentiation of duties, toward introduction and development of that functional type of organization referred to by Harrington Emerson in the leading article in this issue. To an increasing extent, probably, the university must enlist the co-operation of the specialist in active professional practice; but to secure his co-operation, it must be made more possible than it is now for him to work freely and efficiently. The problem is one of efficiency; and unfortunately, the highest governing bodies of our universities, upon whose decisions and acts the rapidity of this evolution in efficiency must depend, are drawn chiefly from professions or occupations in which the principles of efficiency are least understood and least recognized—the church, the law, and finance.

An Incident of Naval Reorganization.

THE exit of Paymaster-General Rogers is a painful but plainly necessary incident in the effective reorganization of the United States Navy, which Secretary Meyer is carrying out. A department so closely concerned with the efficiency records the plan purposes to secure must be especially administered in harmony with it, or the discordant factor must be eliminated. It should be remembered that the Pay Department claims the authorship of the cost system in force. In view of the curiously obsolete methods now alleged to be employed for the principal records, it would seem that sorrow over the retirement of an earnest and active official might be tempered by hope that, without introducing any of the intricacies in which some professional accountants delight, a more illuminating practice might be introduced.

It is unfortunate, as pointed out elsewhere in these pages, that when new principles are presented, some men, used to the older order, make a personal issue of the matter—as if a good, honest calculator, versed only in multiplication and division, should regard a table of logarithms as an attack on his character.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

LABOR INSURANCE IN THE UNITED STATES.

A DISCUSSION OF THE UNSATISFACTORY FEATURES OF EMPLOYERS' LIABILITY INSURANCE IN THE UNITED STATES AND POSSIBLE MEANS OF IMPROVEMENT.

Miles M. Dawson—National Metal Trades Association.

THE discussion of employers' liability insurance before the National Metal Trades Association at the recent convention in New York is only one of many indications that the establishment of a rational basis for workmen's compensation for accidents is at last receiving general recognition as one of the most important industrial problems of the United States. In four States—New York, Minnesota, Illinois and Wisconsin—the problem is being studied by legislative commissions, all of whom have under consideration the German system of labor insurance. During the month of April voluntary plans providing for liberal compensation for accidents were announced by two large corporations, the United States Steel Corporation and the International Harvester Company. The acceptance of the problem by an association of employers of national scope, however, is highly significant, and the interest manifested in the plan for the establishment of a mutual insurance fund proposed by Miles M. Dawson to the National Metal Trades Association is a strong encouragement to the hope that a long-standing reproach on American industrial methods will soon be removed. We quote at length from Mr. Dawson's paper.

"As at present supplied in the United States, employers' liability insurance consists of an insurance company undertaking for a consideration, called a premium, to assume the liability of the employer to his employees who are injured by reason of what the law terms negligence, and to the next of kin of employees who lose their lives through his negligence. In practice it consists in the insurance company making it a business to drive as hard a bargain as it can in the settlement of claims of this nature or to resist such demands and defend against them in the courts if necessary, according as one course or the other may seem less expensive or for any other good business reason more desirable.

"This system has not proved satisfactory to any of the parties in interest. It is not satisfactory to employers, because, while it appeals to them as a ready means of escaping annoyance and occasional excessive verdicts, it involves the payment of large amounts which go for agency, adjustment, home office and other expenses, and which must be paid by the employers in addition to the sums that actually reach the injured employees and the next of kin of employees who are killed. It is unsatisfactory to the companies because they find that there is constant pressure upon them to be more liberal in their settlements since the employer is not directly affected by each settlement, and at the same time equally constant pressure upon them to furnish the insurance at lower premiums. They also tire of being continually in the courts or continually resisting the payment of claims, and competition among them is resulting in several of the companies choosing to make prompt settlement in as many instances as they can, instead of standing upon their rights under their contracts and under the liability law. It is not satisfactory to the workmen and their next of kin because they are confronted with a purely business proposition at a time when there may be very great need, and when, under the old conditions, the employer might, and very likely would, as a matter of sympathy, contribute to their relief, even though not liable under the strict letter of the law. Another objection on their part is that litigation is more expensive to them, longer drawn out, more bitterly fought and the defense conducted by men of special skill in such matters. They also urge that often advantage is taken of their necessities to drive a specially hard bargain without their being made aware of their rights in the matter.

"There is also a fourth party to the transaction—the public. Whatever employers or employees fail to do for the relief of the victims of industry falls upon the public in the most unfortunate form of charity or even, eventually, by reason of the impoverishment of families and the consequent failure to educate and train children, through courts and prisons.

"The superior efficiency of German workmen, on the whole, is very largely ascribed by everybody to the system of employers' liability insurance which has been introduced in Germany.* The general impression in the United States is that Germany has a system of State insurance, where the State collects premiums from the employers, administers the funds, pays the claims and in general manages the whole affair. The fact is precisely the contrary. The system is one under which the trades themselves are organized into mutual trade associations such as your own, to which every person or company engaged in that trade is by law required to belong and which are managed by their own members. The liability to employees is transferred from the individual employer to these trade associations, and the amount of liability is absolutely fixed by law and is likewise entirely independent of questions of negligence, so that there is no quarrel over whether the employer is liable or not. The only difference of opinion that arises is when there is partial disability, the degree of which has to be determined. While these associations are conducted at an expense of about 10 or 12 per cent., it is generally conceded that their effectiveness, both in the shrewd and careful management of their business and also in bringing about the adoption of safety devices and a reduction in the hazards of industry, far exceeds that of any system which has been introduced in any other country.

"Under the German system the amount of liability in event of total disablement is fixed at a certain proportion of the wages and is payable like wages—that is, by weekly payments. In the event of partial disability an amount proportionate to the impairment of the earning power is paid. In the event of death a pension is paid to the widow during her widowhood—that is, until her death or remarriage—and a pension to each child until he reaches 16 years. These pensions in the aggregate must not exceed the amount that the man would have received himself had he been totally disabled. This system I personally regard as the most satisfactory one for employers' liability insurance that can be found in any country. It could be introduced here, precisely as it is in Germany, only by means of legislation. If there were such legislation, as our national Constitution now stands, it would apply only to individual States and would take effect in those States only when adopted by their respective legislatures."

Besides the usual form of employers' liability insurance, four methods of voluntary insurance are available to individual employers or to trade associations of employers under the laws existing in the United States. One of these is the workmen's collective policy, issued by a liability insurance company for protection of workmen, without regard to liability, the employer's contribution toward the premium entitling him to be protected against liability either under the terms of the collective policy or by another policy at a reduced rate. A more recent form of insurance is the "employer's compensation policy," under which the employer is authorized to compensate his employees for injuries sustained, without regard to liability, on the basis of the wages earned at the time of injury, the insurance company undertaking to defend the employer in the event of a suit, in other words, to protect him against liability. The third method is a system of insurance, paid for by monthly premiums and furnishing sick benefits as well as accident benefits, the employees either contributing the whole or the employer making such contributions as he may desire, no arrangement being made to relieve the employer from liability. The fourth method is by a mutual insurance fund created by and among the employees and supported by their contributions, either assisted by contributions on the part of the employer or entirely independent of such contributions. When the employer contributes, it is common for him to have either an agreement in advance that he shall not be held liable under the law, or else that a receipt and release to that effect must be given before any portion of the benefits provided by the fund can be drawn.

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* A complete description of the German system was published in THE ENGINEERING MAGAZINE for July, 1907.

"It cannot be said that any of these systems is, except in rare cases, at all to be compared with the system in use in Germany. The difficulty with each of the first three is that the benefits are not large for the contributions made. Relatively large expenses are unavoidable. There must be solicitation by agents, usually not only of the employers but also of the employees. There must be collection expenses to be paid by commissions or otherwise; there must be adjustment from some central office—with the sole exception of the new 'employers' compensation policy,' which provides for direct settlement of claims—and there must be litigation which is costly on both sides. None of these three approaches the fourth, or mutual, method either in economy or in avoiding litigation. Under mutual schemes to which employees contribute, and especially if employers also contribute, there is usually a reasonably complete provision made for the maintenance of the disabled employee and his family; and, since this provision is immediately available there is usually no question raised as to accepting it and going forward without calling in the lawyers or the courts. The expenses should rarely, if ever, exceed 10 per cent. of the amount paid out in benefits; whereas it is not probable that any of the others can be operated at an expense of less than from one-third to one-half of the total amount paid—in other words, from 50 cents to $1 for each dollar of benefit." In Germany a system of this character in operation at the Krupp works is considered more beneficial and more satisfactory than even the perfected plans introduced by the Government.

"There would be obvious advantages if the members of the Metal Trades Association could and would combine to cover their liability and to provide for their injured workmen and the families of workmen who are killed through their mutual trades association or a subsidiary association connected with it; and if this were established upon a sound insurance and actuarial basis, unquestionably a larger measure of relief to the injured and the families of the dead could be given without an increase in expenditure. Indeed, the benefit would be increased nearly, if not quite, 50 per cent. as compared with the cost of employers' liability insurance. Yet these benefits could be paid without an increase of cost to the manufacturers, by permitting and encouraging or, best of all, requiring employees to contribute in order both that larger benefits might be paid, and also that all sicknesses and disabilities might be covered without regard to negligence, and also without regard to whether they are incurred while the workmen are at work or when they are off the work.

"There is nothing Utopian or altruistic in such a proposition. It has been thoroughly proved to be a businesslike thing to do, resulting in great economies directly and indirectly, and also in creating a body of unusually efficient, reliable and steady workmen."

THE PROTECTION OF PILES IN SEA WATER.

A REVIEW OF METHODS OF APPLYING CONCRETE SHIELDS TO SUBMARINE PILING ON THE PACIFIC COAST.

Ralph Barker—National Association of Cement Users.

IN a recent number of this magazine, General W. A. Jones has described the devastation wrought by marine borers on wooden submarine structures, and has given an outline of the methods of protecting piling commonly employed. Marine borers, particularly the *teredo,* infest the waters of the Pacific Coast in enormous numbers. So destructive are they that in as short a time as eight months the bearing capacity of untreated fir piles is practically destroyed, and it is absolutely out of the question to use untreated timber in water in which the *teredo* occurs, except for extremely temporary work. On account of the cheapness of the method, impregnation of piles with creosote or some other chemical distasteful to the borers has been widely employed on the Pacific Coast, but, as General Jones has pointed out, this method of protection has been only an indifferent success. It is being rapidly superseded by the application to piles of a surface layer of some material impervious to the attack of the borers, and as concrete is the cheapest, most readily available and most easily applied material, a rapid extension of its use for this purpose may be expected.

Ralph Barker has given, in a recent paper before the National Association of Cement Users, reprinted in *The Engineering Record* for March 26, a summary of three methods of applying concrete to the protection of submarine piling employed in San Francisco harbor. Two of the methods are applicable only to new structures before the superstructure is in place, while the third may be applied to the piles at any time.

"Since the *teredo* works from the mud line to low water," says Mr. Barker, "and the *limnoria* from low water to high water, it is necessary in order to insure immunity to protect timber from the mud line to high water mark. As the mud line is a somewhat varying factor, it is very desirable to extend the covering to a sufficient depth to preclude the possibility of the unprotected portion of the timber becoming exposed.

"The first method employed in San Francisco harbor covers the use of a metal or wooden cylinder around the pile and filling same with concrete. This method was first introduced in 1894. Steel cylinders 3½ feet in diameter were used around a cluster of three piles. First the piles were driven in the proper locations, then the mud was removed from inside the cylinder to a depth specified. This depth was governed by conditions, and was usually about 30 feet below low water. Then concrete sewn up in loose-mesh burlap sacks was placed in the cylinder in sufficient quantity to fill it nearly to low water line. This was allowed to set and the water was then pumped out and the balance of the cylinder filled with loose concrete. This method was later cheapened by the substitution of wooden stave cylinders for the steel.

"The most recent practice in this method is to use, instead of a 3½-foot cylinder, one only 2 feet in diameter, having a cast-iron shoe in its bottom which fits as close as possible around a single pile. Rope grummets are placed around the pile, and as the cylinder is driven the grummet is forced tightly between the casting and the pile, thus making a tight joint, which excludes the mud and water to a very great extent. What mud and water may have gotten inside the cylinder is then removed by a jet pump and the cylinder is filled with concrete, same being reinforced with vertical rods held in place by horizontal bands. The latter practice gives the best results, as the placing of concrete under water, even in sacks, is almost certain to cause a separation of the ingredients. The wooden cylinder is eaten away by the marine insects in a short time, and if the concrete is not perfectly sound the *teredo* enters through the voids in the shield and destroys the piles.

"The second method consists of using a concrete cylinder of about 24 inches external diameter and 2¾ inches thick, heavily reinforced. The length of the cylinder is governed by conditions the same as the wooden cylinder above described, the longest used being 34 feet. The cylinder is driven around the pile, pumped out, and filled with concrete in practically the same manner as when the small wooden cylinders are used. This method gives very good results, as the outer shell is made on the surface, where it can be examined and rejected if defects appear.

"The third method differs essentially from the foregoing, and can be applied to an old structure without removing the top work. It consists of the use of a sheet metal form having a diameter of about 8 inches greater than the pile to be treated, same being placed around the pile in short lengths. The bottom of the first form applied to the pile is equipped with a diaphragm, which fits closely around the pile and accommodates itself to its decreasing size. The form is placed around the pile and has attached to it two wire ropes from a windlass on the floor of the structure. Then a cylinder of reinforcing material is placed inside the form and it is filled with concrete. This section is then lowered into the water sufficiently to allow the next section to be constructed around the pile and fastened to the one already filled. The process is continued until the first section comes to rest on the bottom of the bay. In ordinary mud the weight of the column of concrete will force it down into the bottom a sufficient distance to insure protection.

"All three of these methods give very good results. The last mentioned is the cheapest, but when it is used the pile it protects must extend up to and support the superstructure. In the other two methods the pile may be cut off at low water line, and the balance of the support made a reinforced pillar, getting its lateral strength from the reinforcing bars, which may be made continuous for the full length of the concrete casing.

"As to the type of hydraulic cement best fitted to secure the essential quality of enduring strength when used in sea water, the subject has been, and still is, one of considerable question. The two destructive influences commonly believed to be most necessary to provide against are: (1) The peculiar chemical disintegrating action of the magnesium sulphate content of ocean water upon the aluminium compounds in the cement. (2) The physical wear of the surface of concrete thus chemically affected and softened by the abrasive action of the water, and the greater or less content of sand which it may carry with it."

A cement known as "erz-cement," or "iron-ore cement," in which the aluminium is largely replaced by iron, in order that the chemical action of sea water may be reduced to a minimum, has been placed upon the market in Germany. Reports of tests seem to indicate that iron-ore cement will withstand chemical action much more successfully than Portland cement of the ordinary character. Puzzolan-Portland cement is another material of German manufacture which is practically unattacked by sea water, but as neither Puzzolan-Portland nor iron-ore cement is produced in the United States, the American engineer has been confined in sea-water concrete construction to the use of Portland cement.

"Although disastrous disintegration has occurred in some instances, it is nevertheless true that the great mass of well constructed Portland-cement concrete in sea water has served its purpose satisfactorily. Portland-cement concrete has the power of armoring itself against the action of the magnesium sulphates of the sea water by the formation on its exposed surfaces of a skin or film of lime carbonate. In comparatively still waters this appears to constitute a very effective protection. In case of violent or continued abrasion of water and sand it is naturally less effective, and in exceptional cases has no opportunity to form. In these cases the calcium hydrate set free by the decomposition incident to the hardening of the Portland cement is washed away, leaving voids for the further inroads of the deleterious chemicals contained in these sea waters.

"In selecting a Portland cement for marine construction, the ordinary precautions taken to secure a trustworthy material, that is, careful and accurate sampling and testing, are absolutely essential. That the cement must be sound goes without saying. Since only the very finest portion, the 'float,' of the Portland has cementious value, fine pulverization is essential, and a matter of much economical moment. Too slow a setting is to be avoided, and a rapid permanent hardening is of value. These, however, it is unwise to secure by the use of cements high in aluminium, since it is the aluminium content that is most vulnerable to chemical attack."

THE PHASE ADVANCER, A NEW ELECTRICAL DEVICE.

A NEW SOLUTION OF THE PROBLEM OF IMPROVING THE POWER FACTOR OF INDUCTION MOTORS.

The Electrician.

THE troubles caused by wattless currents are familiar to all engineers responsible for the operation of plants on alternating-current systems where the power factor is low. While these currents load up the generators and mains, they have a demagnetizing effect upon the generator field magnets, calling for increased power for excitation and rendering it difficult to maintain the pressure. In some cases they prevent the full output being taken from the prime movers, thus destroying the possibility of making most economical use of the generating plant. A principal cause of low power factor is the presence of induction motors on the system, and owing to the growth of power loads, the question has arisen whether it is possible to provide at the motor itself a means of compensating for these lagging currents.

A solution of this problem is offered in the "phase advancer," devised by Miles Walker and already described by him in a paper read before the Institution of Electrical Engineers. The device may be briefly described as a special form of exciter connected in circuit with the rotor winding of the induction motor, to which it supplies magnetizing current generated at low voltage and low frequency, the frequency of the slip. Taking a slip-ring induction motor having a power factor of about 92 per cent. on full load, it is possible by means of the phase advancer to arrange that instead of a lagging current the motor may run at unity power factor, or even be caused to take a leading current up to 30 to 40 per cent. power factor, so as to compensate for lagging current taken by other motors, etc., in the system. The development of the machine has now reached a commercial stage, and a unit recently built to be used in conjunction with a 900 kilowatt induction motor has yielded satisfactory results. For a technical description of the construction of the phase advancer we may refer our readers to Mr. Walker's paper, which was read early last year. Our present concern is with the practical possibilities of the invention, which are summarized in *The Electrician* for April 8.

"When the phase advancer is used in connection with an induction motor, the amount of idle power required for magnetising is only a small fraction of that required when the magnetising current is supplied at full frequency and full voltage in the stator winding. This will be appreciated when it is considered that a 750 brake horse-power, three-phase, 50-cycle, 2,000-volt, 590 revolutions per minute motor requires in the stator winding 50 amperes per phase as magnetising current, or an idle power of 175 kilovolt-amperes. When fitted with a 6 kilovolt ampere phase advancer the same motor will run at unity power factor and require no idle power from the mains. If the same motor were fitted with a 12 kilovolt-ampere phase advancer it could be run at a leading power factor of 0.7, when, in addition to its ordinary load, it could also compensate for the lagging currents produced by other motors to the extent of its full kilowatt rating of 600.

"Again, by building a similar motor, but with a larger percentage of copper in its windings, it would be capable of supplying magnetising current to three motors of the same size, when a total power of 3,000 brake horse power would be obtained with the line working on unity power factor, the only cost being the 12 kilovolt-ampere phase advancer and additional copper in one motor. In such an installation, with motors having a power factor as high as 92 per cent. and a voltage drop in the line of 10 per cent. without phase advancers, by the use of the latter a saving in the line losses amounting to about 40 kilowatts could be obtained. Further, a generator specially designed to take a load at unity power factor would be smaller and cheaper, and would have all day losses reduced by about 30 kilowatts. This would give a total saving in generation and transmission of 70 kilowatts, against which must be set losses in the phase advancer and in the winding of the over-compensated rotor, amounting, however, to not more than 6 kilowatts.

"The above case relates to high-speed motors having a good power factor. If, however, we consider slow-speed motors which would have a power factor as low as, say, 0.7, the saving in the line and generators would be not less than 220 kilowatts. In this case two phase advancers would be used, two motors being over-compensated to provide the wattless current taken by the other two, and accordingly in this case the losses in the exciting circuit would amount to about 18 kilowatts.

"An important consideration in connection with the use of the phase advancer is the following: Suppose a large motor with a low power factor at the end of a long feeder; by installing a phase advancer in conjunction with the motor the feeder would be relieved of wattless current, and thus part of its copper set free. Accordingly, new consumers might be connected to the feeder at the end adjacent to the motor, and the revenue obtained from the cable correspondingly increased.

"Another use for the phase advancer is in conjunction with induction motors under conditions where a large slip is required, such as for winding purposes or for driving rolling mills. This slip is at present obtained by inserting resistance in the rotor circuit, which means a large loss of energy. By means of the phase advancer the slip required may be obtained and the power returned to the line, instead of being wasted.

"A further advantageous use for the phase advancer is in connection with induction generators. Such machines have the important advantage over the ordinary alternating-current generator with continuous-current excitation that they may be run up to speed and switched on to the 'bus bars without synchronising. This class of generator has not been very much employed even in cases where it appears to present certain advantages because the ordinary induction generator required to be supplied with magnetising current from the line, and, furthermore, it is incapable of generating any wattless current to supply to induction motors or other apparatus requiring wattless or laging currents. If an ordinary induction generator is connected to a distribution system in parallel with synchronous generators, the synchronous generators have to supply not only the wattless currents required by their share of the load and the wattless currents required by the rest of the load, the true watt part of which is carried by the induction generators, but they are also called upon to supply further wattless currents to magnetise the induction generators. So that instead of being a help in that part of the load which is most trying to every generator, the induction generator is actually a further drag on the system. By means of the phase advancer this drawback of the induction generator is overcome, and it is possible to build an asynchronous generator which not only supplies its own magnetising current but is able to supply wattless currents to other parts of the system. Such machines should be particularly useful where it is intended to feed power into a system of mains, as from a waste-heat station or from a small isolated water-power station, and where it is undesirable to connect a synchronous machine to the system; or, further, in a station having synchronous generators driven by reciprocating engines, the use of an induction generator in conjunction with an exhaust steam turbine and a phase advancer should be of great service.

"Asynchronous generators may also be of great service for light loads in towns liable to fogs in the winter months. Due to such fogs coming on quickly, it often happens that the load increases more rapidly than the attendants can parallel and switch in synchronous generators. In such cases there will be no difficulty in simultaneously starting up induction generators, which could be switched in circuit through choke coils, the latter being afterwards short-circuited. A further use for induction generators is in connection with slow-speed gas engines, such as are fed from coke-oven gas, and for use on 50-cycle circuits. The irregular turning moment of these engines and the great number of poles make parallel running rather difficult, particularly if the generators have to run in parallel with other machines to which they are connected by means of long lines. In such cases some at least of the generators could be advantageously made of the asynchronous type, and by means of phase advancers, could be made to take their share of the wattless currents.

"In general, phase advancers are designed for low voltage and a comparatively large current. They are fitted with compensating windings to ensure perfect commutation at all loads. Consequently, no sparking or burning takes place at the brushes and the commutator remains bright, requiring practically no attention. The brushes are of carbon and wear very slowly, so that they will only require to be renewed after a long period of continuous service. The phase advancers are designed either for direct coupling or for separate driving by belting, etc. For starting purposes, in conjunction with a motor, the only addition to the arrangement is a three-pole double-throw switch, which is required to switch in the advancer after the motor has been started in the usual way."

The unit referred to above has been tested by running it in conjunction with a 750 brake horse-power, three-phase, 50-cycles, 2,000-volt induction motor forming the motor end of one of two motor-generator sets which were run loaded back upon each other, the speed of each set being 590 revolutions per minute. The current passing through the machine was 600 amperes. The power taken to drive the phase advancer was about 1 per cent. of the power of the motor in conjunction with which it operated. The following table shows the readings obtained:

Reading.	Volts.	Kilowatts.	Power factor.	Remarks.
1	1,840	280	86% lagging.	Phase advancer not running.
2	1,840	300	Unity.	" " running
3	2,200	375	Unity.	" " "
4	2,600	375	50% leading.	" (increased speed)
5	2,000	20	50% leading.	" (speed as before)
6	2,600	312	40% leading.	" (increased speed)
7	2,560	20	5% leading.	" (speed as before)

NOTE.—The voltage was regulated by hand, to be constant for readings 1 and 2. A comparison of readings 3 and 4 shows a rise in the generator voltage due to the phase advancer having substituted leading and magnetising for lagging and demagnetising currents.

PRODUCER GAS POWER IN THE UNITED STATES.

A SUMMARY OF THE DIFFICULTIES IN THE WAY OF A MORE RAPID INTRODUCTION OF GAS-POWER PLANTS.

R. H. Fernald—United States Geological Survey.

AN exhaustive investigation of the development of the producer-gas power plant in the United States has recently been concluded for the United States Geological Survey by Prof. R. H. Fernald, whose report now appears as Bulletin 416 of the Survey publications. Nearly all of the 500 plants now in operation have been installed since 1900. They range in size from 15 to 6,000 horse power. About 12 per cent. are operated with bituminous coals and lignites; the remainder use anthracite or other smokeless fuel. The bituminous and lignite producers, however, represent about 57 per cent. of the total power capacity of the plants, and the capacity of the individual bituminous plants averages about 12½ times the capacity of the plants using anthracite.

The introduction of producer-gas power has progressed steadily during the past ten years. But when the superior fuel economy of the gas over the steam power plant is considered, it is not immediately apparent why the rate of progress has not been more rapid. The results of tests conducted by the United States Geological Survey with 75 coals, 6 lignites and one peat show an average ratio of fuel fired per brake horse power in steam-boiler compared with prducer plants of 2.7 to 1. A part of the voluminous data collected by the Survey in the recent investigation consists of the opinions of manufacturers and users of gas-power plants as to the difficulties in the way of a more rapid introduction of producer-gas power. From these opinions Prof. Fernald draws the general conclusions summarized below.

"1. It is still commonly believed that the gas engine plant cannot be so reliable as the steam engine. This obstacle to development is generally believed, by the manufacturers at least, to be largely due to lack of information. It is certain that gas-power plants are being operated with perfect reliability and satisfaction, where the conditions have been properly studied and the apparatus has been selected to meet these conditions.

"2. The lack of enginemen, experienced in operating producer-gas plants, is still a difficulty at times. The situation is much better than three years ago and this trouble will disappear in time.

"3. Inexperienced salesmen—men not familiar with the details of the engines and producers they sell and uninformed as to the conditions of selection of apparatus for best operation—are still in the field but, by attention from manufacturers, they are being eliminated.

"4. The influence of a large number of unsuccessful gas-power plants installed during the earlier period of development has not entirely been overcome by knowledge of the success of the best designs of reliable companies. Some unsuccessful installations are found in recent plants of the unexperienced manufacturers and also where some new designs have been tried out. Poor design and construction in some of the apparatus still being marketed reflect on all apapratus. The reliable companies offer a well tried, well built machine, which others imitate with a cheaper equipment having a similar appearance.

"5. Many factory buildings must be provided with a heating plant separate from the power plant, if a gas engine is installed. This prevents the sale of many gas-power units, which would be made if a satisfactory way were devised for this heating.

"6. While the investigations of the Survey have demonstrated that an excellent gas can be made from bituminous coals, yet the lack of types of producers which will *satisfactorily* gasify such fuels is still felt. In the 'up-draft' producer the mechanical extraction of tar is troublesome. In the 'down-draft' system the excessive labor in cleaning the fires prohibits the continuous operation of most single-generator plants. Inability to use still cheaper fuels has to be contended with. Although a few plants are operating successfully on lignite, there is opportunity for further development here.

"7. Lack of complete knowledge as to how successfully the various fuels in different localities can be used, while an obstacle at present, is being relieved by the work of the Geological Survey. As the results of its tests are published, information will become available concerning the various fuels of the country.

"8. The excessive first cost of gas-power over steam plants is felt. For the larger complete installations, say, from 4,000 to 5,000, the cost is about the same as of a first-class steam plant of the same capacity.. With smaller installations the steam plant costs considerably less. Some manufacturers have stated that the high selling cost of gas-power plants is not warranted by the shop cost. This probably results from the cost of development of new apparatus and the expense of educating purchasers to the proper use of gas plants. Nevertheless, even if the steam plant costs 15 per cent. less than the gas plant, the increased efficiency in operating the latter will make up the difference within two or three years. This would hold true of course only where the hours of operation or of heavy load periods were long enough so that the total decrease in fuel charges could equal or exceed the extra fixed charges.

"Producer gas-plants of 20 and 2,000 horse-power capacity cost from about $105 to $46, respectively, per horse power of installation, exclusive of buildings and foundations. Including buildings and foundations, these figures will be $108.50 to $47.50. Complete plants of the larger type from 1,000 to 5,000 horse-power capacity cost from $93 to $70 per horse power, including foundations, buildings and all auxiliaries.

"9. Over-rating of American producer plants has come about very naturally through the adoption of European figures for rates of fuel consumption in the days of early development. Experience has shown that American fuels are so decidedly different that equally decided modifications in the fuel rates must be made. Some manufacturers are now re-rating their apparatus, while others are still using grate areas too small for the loads on the producers. In inspecting a large number of installations throughout the country it was frequently observed that with good anthracite fuel no difficulty was experienced in working the producer up to 50 or 75 per cent. of the rated capacity, but if the apparatus was forced to its full rating for any length of time, clinkering and other operating difficulties were met. These were often sufficiently serious to necessitate a reduction in load at a most inconvenient time."

ELECTRIC MOTORS FOR MACHINE TOOLS.

A SERIES OF TABLES GIVING STANDARD SIZES AND SPEEDS OF MOTORS FOR DRIVING VARIOUS CLASSES OF MACHINE TOOLS.

Charles Robbins—American Society of Mechanical Engineers.

WE have already given in these columns* a summary of standard practice in the selection of motors for driving machine tools of various classes and in the application of the motors to the tools. In the tables following will be found a summary of the sizes and speeds of motors normally selected for this work. These tables appear as an appendix to an interesting paper by Charles Robbins on economic features of electric-motor applications, presented before the American Society

TABLE I. SIZES AND SPEEDS OF MOTORS ON LATHES.

ENGINE LATHES.

Adjustable speed, ratio 1 : 3.

	LIGHT DUTY.			MEDIUM DUTY.			HEAVY DUTY.		
Swing, Inches.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.
14	2	Ratio	1,800	3	Ratio	1,800	5	Ratio	1,200
16	3	1:3	1,800	5	1:3	1,200	5	1:3	1,200
18 20	3		1,800	5		1,200	7.5		1,200
22 24	5		1,200	7.5		1,200	10		1,200
27-30	7.5		1,200	10		1,200	15		1,200
36-48	7.5		1,200	10		1,200	20		900

SPECIAL LATHES.

Type.	Horse Power.	Adjustable Speed.
Car wheel, 48 inches	20	1:3
Double axle, moderate duty	15	1:3
Heavy duty	25	1:3

DRIVING-WHEEL LATHES.

Size, Inches.	Horse Power.	Adjustable Speed.
51	15	Ratio 1:3
60 69	20	
79	25	1,200 r. p. m.
84	25	
90	30	
100	50 5 tail stock	

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* THE ENGINEERING MAGAZINE, February, 1910.

TABLE 2. SIZES AND SPEEDS OF MOTORS ON VERTICAL BORING MILLS.

Size, Inches.	Horse Power.	Adjustable Speed.	.Constant Speed.
24-30	5	Ratio 1:3	1,200
36-42	7.5		1,200
60-90	10 5-rail		1,200
100	15 5-rail		1,200
120	20 7.5-rail		900
144	20 7.5-rail		900
168	25 7.5-rail		900
192	30 10-rail		900

TABLE 3. SIZES AND SPEEDS OF MOTORS ON DRILLS.

RADIAL DRILLS.

Size, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
48	3	Ratio 1:3	1,800
60	5		1,200
72	5		1,200
120	7.5		1,200

UPRIGHT DRILLS.

Friction.	0.25	Ratio 1:3	1,800
15	0.5		1,800
20-26	1		1,800 1,200
28-34	2		1,800 1,200
42-50	3		1,800 1,200

MULTIPLE-SPINDLE DRILLS.

4-2	7.5	Ratio 1:3	1,200
6-2	10		1,200
8-2	10		1,200

TABLE 4. SIZES AND SPEEDS OF MOTORS ON MILLING MACHINES.

HORIZONTAL, PLAIN OR UNIVERSAL.

Table Feed, Inches.	Cross Feed, Inches.	Vertical Feed, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
24	8	18	3	Ratio 1:3	1,800
30	10	18	5-7.5		1,200
36	12	20	7.5-10		1,200
50	12	20	10-15		....

VERTICAL MILLING MACHINES.

Table Diameter, Inches.	Spindle Diameter, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
28	4	5	Ratio 1:3	1,200
32	4	7.5		1,200
40	4.5	10		1,200
54	5	15		1,200
70	6	20		900

SLAB MILLING MACHINES.

Width of Table, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
24-30	10	Ratio 1:3	1,200
36	15		1,200
60	25		900
36 heavy	25		900
42 “	50		900

TABLE 5. SIZES AND SPEEDS OF MOTORS ON HORIZONTAL BORING, DRILLING AND MILLING MACHINES.

Spindle, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
3.5	3	Ratio 1:3	1,800
4	5		1,200
5	7.5		1,200
6	10		1,200
7	15		1,200

TABLE 6. SIZES AND SPEEDS OF MOTORS ON PLANERS.

MEDIUM DUTY.			HEAVY DUTY.		
Size, Inches.	Horse Power.	Constant Speed.	Size, Inches.	Horse Power.	Constant Speed.
24x24	5	900	24x24	7.5	900
30x30	7.5	900	42x42	25	900
36x36	10	900	56x56	25	900
48x48	15	900	Frog and	30	900
56x56	15	900	Switch Forge	..	...
			12x10 feet.	60	720
				10 (rail)	...
			14x12 feet.	75	...
				12 (rail)	720

TABLE 7. SIZES AND SPEEDS OF MOTORS ON SHAPERS.

Size, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
14-20	3	Ratio 1:3	1,800
24	5		1,200
36	7.5		1,200

TABLE 8. SIZES AND SPEEDS OF MOTORS ON CRANK SLOTTERS.

LIGHT, MEDIUM AND HEAVY.

Size, Inches.	Horse Power.	Medium.	Adjustable Speed.	Constant Speed.
10	3	5	Ratio 1:3	1,800
10-16	5	7.5		1,200
20	7.5	10		1,200
26-30	15	..		1,200
		GEARED SLOTTERS.		
24-60	20	..	1:3	900

TABLE 9. SIZES AND SPEEDS OF MOTORS ON COLD SAWS.

Diameter, inches.	Thickness, inch.	Horse Power.	Adjustable Speed.	Constant Speed.
12	5/32	2	Ratio 1:3	1,800
15	5/32	2		1,800
18	3/16	3		1,800
20	3/16	3		1,800
24	3/16	5		1,200
32	3/16	7.5		1,200
36	3/16	10		1,200

TABLE 10. SIZES AND SPEEDS OF MOTORS ON GRINDERS.

	Horse Power.		
Size, inches.	Medium.	Heavy.	Constant Speed.
10x 50	5	7.5	1,200
10x 72	5	7.5	1,200
10x 96	5	7.5	1,200
10x120	5	7.5	1,200
14x 72	10	..	1,200
18x120	10	15	1,200
18x144	10	15	1,200
18x168	10	15	1,200
18x 96	10	15	1,200
44 inch car-wheel grinder		30	900

of Mechanical Engineers and printed in the *Journal* for April. With Mr. Robbins' discussion of the method of handling a problem in motor drive in order to show its maximum economy, to which the paper proper is devoted, we have, unfortunately, no space to deal.

The tables show the sizes and speeds of motors usually employed with the average duty indicated for machine tools. The constant-speed motors are selected with a view to utilizing speeds as near as possible to those obtainable with 60-cycle induction motors. By this means the same gear ratios can be employed with either direct-current motors or 60-cycle induction motors.

Mr. Robbins has made extended studies of machine-tool operation which have demonstrated that few tools are in operation more than 50 to 60 per cent. of the time; the load factor in some cases may be as low as from 10 to 40 per cent. An analysis which took into account the time of loading, cutting, unloading, and the delays occasioned by miscellaneous causes showed conclusively that it is not necessary to use a continuously rated motor; in fact, an intermittent rating on the motor for a period not exceeding two hours' continuous service answers for almost all kinds of machine-tool applications. The average load factor for motors driving lathes, for example, is from 10 to 25 per cent. On some special machines, as driving-wheel and car-wheel lathes, the cuts are all heavy, which increases the average load factor to from 30 to 40 per cent.

For extension boring mills, 5 horse-power motors are used to move the housings on from 10-foot to 16-foot mills, 7.5 horse-power motors for from 14-foot to 20-foot mills, and 10 horse-power motors for from 16-foot to 24-foot mills. The load factor of the driving motor on boring mills averages from 10 to 25 per cent. The load factor of motor-driven drills is about 40 per cent., when the larger drills applicable thereto are used. If the smaller drills are used the load factor averages 25 per cent. and lower.

For the average milling operations, the load factor averages from 10 to 25 per cent. On slab milling machines where large quantities of metal are removed it will average from 30 to 40 per cent. The work on this class of machinery is usually light and much time is required in making adjustments. Hence the load factor is rarely higher than 20 per cent. On planers the load factor averages between 15 and 20 per cent. The motor must be large enough to reverse the bed quickly, yet this peak load occurs for such short intervals that it does not increase the average load per cycle very much. The work done on shapers is of a very varying character. With light work the load factor will not exceed from 15 to 20 per cent.; with heavy work the load factor will be as high as 40 per cent. The conditions encountered on slotters are similar to those on shapers.

THE HARDENING OF TOOL STEELS.

A SUMMARY OF THE RESULTS OF A RESEARCH ON THE HARDENING OF CARBON AND LOW-TUNGSTEN TOOL STEELS.

Shipley N. Brayshaw—Institution of Mechanical Engineers.

IN a monograph which covers 159 pages, Shipley N. Brayshaw has communicated to the Institution of Mechanical Engineers the results of an exhaustive research on the hardening of carbon and low-tungsten tool steels, which constitutes a part of an investigation begun about seven years ago on the hardening of tool steels in general. The present paper deals exclusively with results obtained from two kinds of carbon tool steel, which, except for accidental variations, differed only in the fact that one of them contained about 0.5 per cent. of tungsten. These steels, Mr. Brayshaw finds, have a long range of quite 120 degrees C. (216 F.) within which they may be hardened to show a good fracture. So wide is the margin of allowable variation for hardening as ordinarily carried on, and tested by the appearance of the fracture, that a workman of average skill can easily keep within the limits, judging the temperature by sight alone. It is easy to harden so as to produce a good bar, but the production of the best bar necessitates a degree of accuracy beyond what can be attained by sight alone. Further, the difference between the good bar and the best bar is very great. Mr. Brayshaw does not advocate that all tool-steel hardening should be carried on with the precision necessary to bring the steel into its best condition, but he believes it possible to bring the various operations connected with steel hardening under such control, by means of methods of precision, that different hardeners in different places should be able to produce exactly similar results from the same hardening instructions.

A summary of the voluminous data accumulated by Mr. Brayshaw in his investigation of precise methods of control for carbon and low-tungsten steel hardening is given below. The six steels on which the experiments were made had the following percentage compositions:

	W 1	W 2	W 3	W 4	A 1	A 2
C	1.18	1.16	1.19	1.15	1.16	1.14
Si	0.18	0.10	0.23	0.21	0.07	0.09
Mn	0.42	0.37	0.28	0.31	0.37	0.40
W	0.47	0.48	0.57	0.50	...	...
S	0.023*	0.023	0.012*	0.012*	0.018*	0.018
P	0.014*	0.014	0.011*	0.011*	0.014*	0.014

*Approximate.

All heating was done by immersion in a hot liquid in a special furnace designed by Mr. Brayshaw. Molten lead and alloys were given a prolonged trial, but the mixture finally chosen was a patent melt mainly composed of the chlorides of sodium and potassium.

From an examination of the heating and cooling curves of low-tungsten steel, Mr. Brayshaw concludes that if the temperature has been raised up to or beyond 880 degrees C. (1,616 F.) it is more difficult for the steel to change into the post-recalescence condition; that is to say, that at about the temperature of 880 degrees C. the point of subsequent recalescence is lowered and also rendered much less liable to alteration by the rate of cooling. An investigation of the influence of maximum temperature and rate of cooling upon the recalescence (designated Ar 3, 2, 1) shows that the recalescence of low-tungsten steel takes place gradually at a temperature of 731 degrees C. (1,348 F.) and more readily at 725 degrees C. (1,337 F.); further the recalescence at either of the above temperatures is very much retarded if the steel is cooled from a maximum heat of 890 degrees C. (1,634 F.). There is a post-recalescence condition of low-tungsten steel reached by first heating above the halt on the heating curve (designated Ac 1, 2, 3) and then immediately soaking at certain temperatures between the halts Ac 1, 2, 3 and Ar 3, 2, 1. If the steel is quenched from this condition it is softer than the same steel which has been quenched after merely soaking at these temperatures between the halts Ac 1, 2, 3 and Ar 3, 2, 1, without having undergone the previous higher heat.

Bending tests on bars, to determine the effect of heating to various temperatures, demonstrated that the hardening point of both low-tungsten and carbon steel may be located with great accuracy. The complete change from soft to hard is accomplished within a range of less than half a dozen Centigrade degrees (11 degrees F.). The hardening point so ascertained coincides of course with the halt Ac 1, 2, 3 on the heating curve of the same steel. After the temperature has been raised more than 20 or 30 Centigrade degrees (36 to 54 degrees F.) above the hardening point, the hardness of the steel is lessened by further increases in the temperature, provided that the heat is sufficiently prolonged for the steel to acquire thoroughly the condition pertaining to the temperature. There is a change point at about 880 degrees C. (1,616 F.) in low-tungsten steel and at a somewhat higher temperature in carbon steel. One of several indications of this change point is the shortening of bars hardened in water from temperatures below the point, whereas the bars lengthen if the temperature in question is exceeded at the time of quenching. Practically the same results are obtained by heating low-tungsten bars to any temperature from 760 to 940 degrees C. (1,400 to 1,726 F.) and quenching in oil.

Prolonged soaking for hardening at a temperature of about 760 degrees C. (1,400 F.) has a slightly injurious effect but does not materially affect the hardness. At a temperature of about 810 degrees C. (1,490 F.) a great degree of hardness is attained with a short time in the melt, and the hardness is impaired with 30 minutes' soaking. Prolonged soaking for hardening at a temperature of about 880 degrees C. (1,616 F.) has a seriously injurious effect upon the steel. A specially great degree of hardness may be attained by means of soaking at a high temperature such as 880 degrees C. (1,616 F.) for a very short time, but even 7 1-2 minutes is long enough seriously to impair the hardness. As to the temperature of brine for quenching, both low-tungsten and carbon bars quenched at 5 degrees C. (41 F.) are decidedly harder than bars quenched at 24 degrees C. (75 F.) and quenching at 51 degrees C. (124 F.) renders the bars much softer.

The elastic limit of low-tungsten bars hardened at either 760 or 860 degrees

C. (1,400 or 1,580 F.) varies greatly according to the annealing they have undergone. The elastic limit is high after annealing at 800 degrees C. (1,472 F.) for 30 minutes or 700 degrees C. (1,292 F.) for 120 minutes, but it is seriously impaired by annealing at 800 degrees C. for 120 minutes. If low-tungsten bars are annealed at 940 degrees C. (1,724 F.) and hardened at 760 degrees C. (1,400 F.) the elastic limit is inferior, and the adverse effect of the previous annealing is much more pronounced if the hardening is done at 860 degrees C. (1,580 F.). The elastic limit of carbon bars annealed at any temperature from 700 to 940 degrees C. (1,292 to 1,724 F.) and hardened at either 760 or 860 degrees C. (1,400 or 1,580 F.) does not vary by nearly such great amounts as the elastic limit of similar low-tungsten bars, and, furthermore, the highest annealing temperature given above is not injurious so far as the elastic limit is concerned. The hardness of low-tungsten bars hardened at 760 degrees C. (1,400 F.) decreases from a high scleroscope figure to a low one as the temperature of annealing increases from 700 to 940 degrees C. The hardness is increased by prolonging the annealing at the lower temperatures. The hardness of low-tungsten bars hardened at 860 degrees C. (1,580 F.) is fairly constant at a moderately high scleroscope figure whatever the tempeature of annealing.

An extended investigation was made of two-furnace heats for hardening, the process of heating the bars first in one furnace to a certain temperature for a given time and then immediately, without intermediate cooling, soaking in a second furnace at a known temperature and time. The results show that low-tungsten and carbon bars heated for 30 minutes to temperatures of 840 to 900 degrees C. (1,544 to 1,652 F.) are not much affected so far as their elastic limit and maximum stress are concerned by a further immediate soaking for 30 minutes at 760 degrees C. (1,400 F.). If, however, the temperature in the first furnace is 940 degrees C. (1,724 F.) the low-tungsten steel is much improved by the further soaking at 760 degrees C., but the carbon steel is much injured by the same treatment. Bars of this low-tungsten steel heated for 30 minutes to 880 degrees C. (1,616 F.) and then soaked at 722 degrees C. (1,332 F.) for a further 30 minutes give a higher elastic limit and maximum stress, and are harder than if the second soaking were at a temperature of 760 degrees C., but the carbon steel is little affected by these variations in the second furnace.

The change in length of both low-tungsten and carbon steel bars is much affected by the above variations in the temperature of the second furnace. Very good results as regards the elastic limit and maximum stress and also as regards the hardness, are obtained by a very short soaking, first at a high temperature (say 880 degrees C.) and then at a low one, and the results are best of all when the second temperature is near to or a little below the hardening point. If the first furnace be at a sufficiently high temperature it is easy, either by variations in the temperatures of the two furnaces or by variations in the times therein, to arrive at a treatment by which the bars (both low-tungsten and carbon) neither lengthen nor shorten in hardening. Under the same treatment the carbon bars have a greater tendency to shorten than the low-tungsten.

Experiments on the tempering of bending-test bars are described in which little effect was produced by the tempering at 150 degrees C. (302 F.) for 30 minutes of both low-tungsten and carbon steel bars which had been hardened by a certain process. The tempering at 250 degrees C. (482 F.) for 15 minutes of a well hardened carbon steel bar caused it to soften considerably and to shorten in length, but it was little affected otherwise. In experiments on low-tungsten bending-test bars which had been hardened by a rapid process it was found that the elastic limit was much increased by tempering up to a temperature of 250 degrees C. (482 F.). The maximum stress coincided with the elastic limit in two hardened bars, one of which was untempered and the other tempered at about 150 degrees C. (302 F.) for 15 minutes, but it rose rapidly above that point with further tempering. The deflection due to a given load less than the elastic limit was greatest for the hardened untempered bar and it decreased with the tempering up to 198 degrees C. (388 F.) for 60 minutes. The hardness, as measured by the scleroscope, was considerably reduced by tempering at 150 degrees C. (302 F.) and again by tempering at 200 degrees C. (392 F.), but was not so much affected by further tempering at 250 degrees C. (482 F.). The length of the bars was reduced by tempering up to a temperature of 250 degrees C. and the higher the temperature the greater the reduction in length.

Tensile tests of low-tungsten steel bars showed results which there is no reason to doubt are applicable also to bars of carbon steel. A variation in the hardening temperature of only 5 degrees C. (9 F.), the extremes being respectively above and below the halt Ac 1, 2, 3, had a powerful influence upon the extension under load and doubtless upon the permanent extension, but the maximum stress of the bars so treated did not differ much. A very good bar was produced by quenching from a temperature fully 60 degrees C. (108 F.) above the halt Ac 1, 2, 3. A heat of only 5 minutes duration produced a harder bar than a heat of 25 minutes, the maximum temperature in both cases being 800 degrees C. (1,472 F.) or a little above. On the other hand, the bar which was heated for the shorter time gave a much lower elastic limit. Neither the maximum stress alone nor the hardness alone is necessarily any indication of the general condition of the steel in question, or of the treatment to which it has been subjected.

The effect of tempering up to 300 degrees C. (572 F.) well hardened bars of both low-tungsten and carbon steels was greatly to increase the maximum stress and the elastic limit, but there were some irregularities which were not fully accounted for. Tempering to this temperature reduced (for a given stress) the extension under load and the permanent extension. The greatest effect was produced between the temperatures of 200 and 250 degrees C. (392 and 482 F.). Little effect was produced by prolonging the tempering at 250 degrees C. from 15 to 30 minutes.

THE HOMOGENEITY OF METALS.

A DISCUSSION OF THE INFLUENCE OF HOMOGENEITY ON THE DURABILITY OF STEEL, WITH PARTICULAR REFERENCE TO STEEL RAILS.

Gregory Tagayeff—Iron and Steel Institute.

MICROSCOPIC metallography has demonstrated conclusively that a large proportion of the failures of metals are due less to improper composition for the special purposes to which the metals are applied, than to irregularities of structure in the metals. At the recent annual meeting of the Iron and Steel Institute, M. Gregory Tagayeff gave an admirable summary of the established facts regarding the influence of non-homogeneity of structure on the durability of metals. M. Tagayeff is the author of a report on the homogeneity of rails and the study of structure as a method of testing, which is based on the results of an exhaustive investigation of rails taken from Russian railways. The conclusion expressed in this report as to the importane of homogeneous structure in securing satisfactory service are summarized in his present paper. We reproduce them in the following paragraphs.

"Data derived from the study of the chemical composition, in connection with the wear of rails, do not afford an explanation of the difference in their service. Observation of the service of rails and of other articles (shafts, axles, propeller screws, etc.) indicates that local defects have a predominant influence on their endurance. Flaws and defects observed in rails are particular evidences of non-homogeneity of their internal structure. In order to explain this properly it is necessary to call in the aid of metallography, which studies the structure of metal.

"Structure of steel is determined: (*a*) by the particular arrangement of the different constituents of the alloy (phases) resulting from its physico-chemical equilibrium as represented graphically by melting curves; (*b*) by the external features of these structural elements (form, size, and distribution) resulting from the so-called structural equilibrium, which depends upon the conditions of initial temperature, rate of cooling, cooling temperature, and external mechanical influences, the sum of which constitutes the mechanical and thermal treatment.

"A comparison of the results of fractures, with data from microscopical investigation, can be of great use. In particular, such a comparison confirms the existence of a constant definite correlation between the fracture and the microstructure of steel. The mechanical properties of steel are the resultant of the whole of the properties of the structural elements which the steel contains. The mechanical properties of a metal and its quality, as measured thereby, are functions of the structure. For this reason the structure affords an indication of the strength and endurance of a manufactured steel article.

"The investigation of the deflection of rails by calculation, or by direct measurement of the distortion, does not afford a sufficient explanation of their differences in service and of their defects when in track. Investigation of the microstructure, on the other hand, reveals the presence of strains in the head of a rail due to non-homogeneity of the metal. These strains considerably exceed those calculated from an investigation of the deflection. The predominant influence of impact action in the fracture of a rail in position depends also upon the degree of homogeneity of the metal (limit brittleness).

"The service wear of rails depends both upon the absolute properties of the metal (chemical and morphological composition) and upon a certain relative property due to the distribution of the elements of the metal, that is, its homogeneity. The influence of homogeneity in rails affects their service in all cases considerably more than the action of the separate properties of the metal itself. The extent of homogeneity in rails can serve as an indication for classifying them relatively to the results of their service. The non-homogeneous rails will always be either corrugated or brittle or worn down, according to the character and the local conditions of non-homogeneity in each particular case, without it being possible to establish a hard and fast line between the separate groups of such defective rails. The classification of rails, as adopted in practice, into crushed, brittle, and worn out, only distinguishes them by external appearance, without touching upon the manner and cause of their failure. In particular, the presence of so-called gas bubbles, honeycombs, small porosities, and permeations of ferrous oxide contribute to increase the amount of wear likely to occur, while ghost lines (decarburised surfaces of ferrite, permeated by foreign substances) conduce to brittleness. An irregular distribution of ferrite and pearlite promotes crushing. Sulphide of manganese is absolutely injurious to the strength of rails when segregated and accompanied by cracks.

"The cause of non-homogeneity in rails must be sought for in the various stages of manufacture previous to rolling (the molten metal, and the casting and heating of the ingots), in the rolling itself, and in the conditions of subsequent cooling. Hot rolling and prolonged cooling induce non-homogeneity in the cross section of rails, and lower the mechanical properties of the metal. The non-homogeneity of hot-rolled rails manifests itself by the predominance of ferrite in the periphery of the cross section of the rail, by the difference in the size of the grain, and by the lowering of the elastic limit in the central portion of the head.

"The degree of homogeneity or non-homogeneity can be estimated by the amount of variation of any one of the mechanical properties; as, for instance, that of the limit of elasticity, which best expresses the treatment undergone by the metal. The calculation of the non-homogeneity coefficients of a rail, at its cross section, according to this principle, shows that:—(*a*) satisfactory wear of rails is only possible with a sufficient margin of homogeneity; (*b*) the crumpling of rails is directly proportional to the non-homogeneity of the cross section; (*c*) the coefficient of non-homogeneity in crumpled rails is from five to fifteen times greater than in the case of rails which have preserved their profile after service in the track; (*d*) the homogeneity in rails which have served satisfactorily is five times greater than in crumpled rails.

"Investigation of the structure renders it possible to establish several typical forms which indicate positively unsatisfactory service of manufactured articles of steel. An example is the ramified structure of pearlite in soft and mild steel for axles and rails."

THE ELECTRICAL IGNITION OF COAL DUST.

A REPORT OF AN EXTENDED INVESTIGATION OF THE IGNITION OF COAL DUST BY SINGLE ELECTRIC FLASHES.

W. M. Thornton and E. Bowden—Institute of Mining and Mechanical Engineers.

AN exact scientific basis for the discussion of the vexed question of the liability of coal dust to ignition by electric flashes is provided in a recent paper read before the North of England Institute of Mining and Mechanical Engineers by Dr. W. M. Thornton, reprinted in the *Iron and Coal Trades Review* for April 15. Dr. Thornton and his associate, Mr. E. Bowden, have made upwards of 2,200 experiments with inductive and non-inductive currents, both alternating and direct, at various voltages and intensities, and have succeeded in determining the exact conditions under which dust can be fired by electricity. The data given in the paper are much too numerous for complete reproduction, but the abstract following summarizes all the essential conclusions.

Dr. Thornton first discusses briefly the properties of coal dust under electrification. Dry coal in bulk or in the form of dust is not a conductor of electricity. It undergoes no change when placed for several months between terminals 1 inch apart carrying 480 volts, nor when mixed into a paste with oil is there any change to be detected electrically. If, however, a paste made of coal dust and water is placed between terminals 1 inch apart on a marble base and electrified by either direct or alternating current at 480 volts, sparks pass through the substance of the paste and eventually a large flash strikes across, short circuiting the terminals. This result is not due solely to the presence of water, nor is it due to the conductivity of the flame. It is probably caused by the establishment of a line of carbonized particles of the dust short circuiting the terminals. Again, although a flame caused by the slow combustion of hydrocarbons will not short circuit terminals under moderate pressure, it can be shown that the vapor of a fuse when blowing will do so. A point of some practical importance arises from this. When electric cables are brought along a mine roof, they are sometimes taken into a distributing box from the top. In the event of one of the inner fuses blowing hard, the dividing partition not being sound, the vapor can short circuit the main distributing bars and cause a flash over with all the power in the mains behind it. If, however, the cables are brought in from below, the fuse clears itself without risk to the circuit.

The dust used in the experiments was a mixture of dusts from three different mines. It was not sieved before use and contained 10 per cent. of ash, chiefly calcareous. "The apparatus consisted of a stout wooden box, with a hinged lid, in which was a glass window. The dust was blown in by foot bellows through a ¼-inch glass tube from a storage bottle. Through the sides of the box brass rods were fitted, one fixed, the other free to slide in a sleeve, and with a stout spring so arranged that by a trigger a quick break could be made between the poles if desired. When the free rod was fully drawn back, the distance between the poles was 2½ inches. When testing the action of fuses, two spring contact makers were slipped over the poles and the fuse inserted between them. After each ignition the air in the box was swept out. The break was always at the same rate, and after practice the draft could be adjusted to give always the same cloud."

TABLE I. QUICK BREAK; 100 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

Amperes.	Trials.	Ignitions. Full.	Ignitions. Partial.	Percentage of ignitions.
40	57	0	0	0.0
75	20	0	1	2.5
84	30	1	2	6.6
90	20	1	2	10.0
110	20	3	2	20.0
120	62	10	10	24.0

Least current causing ignition, 70.3 amperes.

TABLE II. QUICK BREAK; 240 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

10.8	15	0	0	0.0
12.0	31	0	3	4.8
15.5	22	0	5	11.3
18.0	44	0	21	24.0
27.0	23	3	16	48.0

Least current causing ignition, 11 amperes.

TABLE III. QUICK BREAK; 480 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

5.79	33	0	0	0.0
6.67	37	3	0	8.1
7.14	39	7	0	18.0
7.65	30	6	0	19.8
10.3	20	12	0	60.0
13.0	10	10	0	100.0
25.0	10	10	0	100.0 (violent)

Least current causing ignition, 5.8 amperes.

TABLE IV. QUICK BREAK; DIRECT CURRENT; INDUCTIVE CIRCUITS.

Volts.	Amp.	Trials.	Ignitions. Full.	Ignitions. Partial.	Percentage of Ignitions.
100	14	20	0	0	0.00
	19	20	1	3	12.50
	32	11	5	6	72.00
235	5.5	48	0	0	0.00
	6.8	38	0	4	5.27
	9.0	37	0	12	16.20
470	1.9	20	0	0	0.00
	2.9	20	0	4	10.00
	5.5	20	6	9	52.50

Least currents causing ignition were 16, 5.7 and 2.3 amperes respectively.

TABLE V. SLOW BREAK; DIRECT CURRENT; NON-INDUCTIVE.

110	7.8	33	0	0	0.0
	10.0	26	1	2	7.7
	16.0	38	17	15	61.5
235	1.45	20	0	0	0.0
	1.90	22	0	2	4.5
	2.10	24	0	10	21.0

TABLE VI. QUICK BREAK; ALTERNATING CURRENT; NON-INDUCTIVE; FREQUENCY, n.

77	170	50	0	2	2.0
$n=40$	300	52	2	2	5.8
100	85	32	0	0	0.0
$n=80$	112	40	0	0	0.0

Least current, 100 amperes at 77 volts.

TABLE VII. LEAST CURRENT WHICH IGNITES COAL-DUST, WHEN INTERRUPTED BY A QUICK-BREAK SWITCH.

Volts.	Amperes. D. C. Induct.	Amperes. D. C. Non-Induct.	Amperes. A. C. Induct.	Amperes. A. C. Non-Induct.	Alternating Current Power-factor.
77	....	....	....	100	0.75
100	16.0	70.3	140.0	...	0.80
240	5.7	11.0	....	...	....
280	....	....	36.0	...	0.80
480	2.3	5.8	14.2	...	0.81
635	....	....	5.2	...	0.83

In coal-mining practice there is little risk of the production of an electric flash in a dangerous place through the fusing of a wire. Attention was therefore concentrated upon flashes produced by the quick breaking of circuits under different conditions of voltage and current. The first experiments were made with direct current, and the circuit was kept non-inductive, the case least favorable to ignition. The object was to find the smallest current which would fire dust, and, if possible, that which always caused ignition. In many cases the ignitions were only partial, and the results have been divided into full and partial ignitions; no case can be considered safe, however, where there is even a partial flare. For the purposes of tabulation, two partial ignitions have been taken as equivalent to one full ignition.

Tables I to III show that with direct, non-inductive current the increase of percentages of ignitions is proportional to the increase of current. The curve obtained by plotting the ratios of change of percentage to corresponding change of current as ordinates and the voltages as abscissae follows nearly a square law; that is, the increase of percentage per ampere is proportional to the square of the voltage. The percentage is, therefore, not proportional to the power of the flash, but to the product of this and the voltage. For a given voltage it has a linear relation to the current; so that the risk of ignition is proportional to the volume of the flash.

In practice direct-current motor circuits are to be classed as inductive, although the field coils are connected across the armature when running and do not affect the flash at break of the main circuit. Experiments were made with an inductance of 1.08 henries, the results of which are shown in Table IV. Comparing the inductive with the non-inductive cases, it will be seen that the influence of inductance has been to lower the limit of safety by one-half at least, and in the 100-volt case to nearly one-fifth of its value in non-inductive circuits. The results of experiments to determine the effect of a slow break, as when a cable parts under a gradually applied load, a condition imitated by drawing the poles slowly apart by hand, are shown in Table V. As might be expected, currents broken in this way were found more liable to produce ignition than when interrupted quickly. In the 480-volt tests, with a current of 0.3 ampere there was one slight ignition; with 0.65 ampere, occasional full ignitions; with 0.9 ampere, ignitions almost every time; and with 1.15 amperes, every flash caused ignition.

In the case of alternating currents, there should be less risk from breakage of cables, on account of the chance that the arc may break in passing through zero current and may not be able to re-establish itself. On the other hand, if the current breaks at the crest of the wave, the flash is larger than for equivalent direct current; this, however, occurs very rarely. The results of experiments with non-inductive alternating currents, using a resistance giving a power factor of 0.92, are given in Table VI. It was not possible to obtain non-inductive currents higher than 112 amperes at 100 volts, and the lowest direct voltage used was 100, for which the least current on non-inductive circuits was 70.3 amperes. It is clear from these figures that the values in the case of alternating currents is not far short of twice that for direct currents. A large number of trials were made with the power factor kept as nearly as possible 0.8, with some inductance and a frequency of 40. The results are summarized in the fourth column of Table VII.

TABLE VIII. RELATIVE SAFETY OF ELECTRIC CURRENTS AT DIFFERENT VOLTAGES.

Volts.	Direct non inductive currents.	Direct inductive currents.	Alternating currents.
100.....	1.0	0.228	2.00
200.....	1.0	0.407	3.56
300.....	1.0	0.438	3.54
400.....	1.0	0.338	2.78
500.....	1.0	0.354	2.09

TABLE IX. QUICK BREAK OF CURRENT.

Voltage.	Least current.	Certain current.	Ratio.
100 direct current..	70.3	270.0	3.80
240 " "	11.0	44.2	4.00
480 " "	5.8	13.0	2.20
1,000 alternating current	4.1	6.4	1.56

Taking direct, non-inductive current as the standard, the relative safety of electric currents at different voltages can be expressed as in Table VIII. The safety ratio of alternating to direct currents increases and then decreases. The risks of ignition are more equal at lower voltages because of the larger volumes, and at higher voltages because of the longer duration of the flashes. The fact that at any given voltage the increase in the percentage of ignitions is proportional to the increase of current, suggests that in any case the probability of ignition is proportional to the volume of the arc; that is, since the arc is drawn out in the same way in each case, to the surface in contact with the dust. The currents required to ignite dust with certainty at every flash are given in Table IX. At higher pressures the ratio is unity; that is, every flash produces ignition whatever the current may be.

Trials were made to compare the action of a blowing fuse on direct and alternating currents with the effect of quick break of circuits. From these it is concluded that:—(1) the more violently a fuse blows, that is, the greater the ratio of the current in the circuit to the fusing current of the wire, the greater is the risk of ignition; (2) the ratio of percentage of ignitions of direct to alternating currents for the same voltage and current is four to one; (3) the nature of the fuse wire does not appear to have much influence; and (4) the least current for ignition is comparable with that for direct non-inductive circuits, probably less in the ratio of 0.7 to 0.8, that is, there is from 40 to 25 per cent. more risk from a fuse than from the same current broken quickly. The determining factor in each case is the volume and duration of the arc.

Certain practical conclusions may be drawn from these results. "Coal dust, although an insulator when dry, becomes a conductor if wet enough for carbonization to take place. The necessity for keeping commutators clean, especially the small gap between live copper and the frame, is obvious. There appears to be no danger of flashing over on 480 volts between live parts 1¼ inches apart unless the deposit of dust is entirely conducting, as from carbon brushes.

"Distributing boxes should be dust and flame tight, and should be in compartments so arranged that the main terminals cannot be short circuited by a flash. Cartridge fuses should be always used where possible, and once used should not be replaced by bare wire or by running wire through an empty tube. Momentary arcs produced by break of cables or conductors can ignite dust; but the current required to do so is very much greater when the voltage is low, and at moderate voltages is greater for alternating than for direct current. This suggests that the arrangement most satisfactory from the point of view of safety, both for flashes and for shocks, is high-tension transmission to a sub-station or transformer house, probably with cables well enough armored to prevent any external flash, and quite low-tension local transmission for power and lighting. Series lighting with incandescent lamps is not to be recommended.

"Although it has been shown that a cloud of coal dust can be ignited by small single flashes, it does not follow that the use of electricity in collieries is dangerous. Electricity is no more dangerous than the supply for domestic use of highly poisonous and explosive coal gas. An efficient leakage indicator is equally necessary for both. No indicator will prevent risk from sudden breakages of either pipes or cables; but in the electrical case there is the advantage that the main supply can, if desired, be cut off by a small leakage current."

PROBLEMS OF REFRACTORY MATERIALS.

A SUMMARY OF PRESENT-DAY NEEDS IN REFRACTORY MATERIALS IN VARIOUS INDUSTRIES.

Kenneth Seaver—Engineers' Society of Western Pennsylvania.

A PAPER by Kenneth Seaver, one of a symposium on present-day needs in structural materials, recently discussed in the Engineers' Society of Western Pennsylvania and printed in the *Proceedings* for April, deals with the unsolved problems of refractory materials. In an early number of THE ENGINEERING MAGAZINE we hope to present to our readers a critical discussion of the methods of mining and fabricating fire-clay by A. S. B. Little, to which the lengthy abstract of Mr. Seaver's paper following will serve as a useful introduction.

"Naturally, the problems relating to high refractories are incapable of an exact and mathematical answer, and the problem of the blast furnace, for instance, the old type furnace using cold blast, required another solution with the advent of the hot-blast stove, and as this was in turn succeeded by the still more modern types with greatly increased temperatures and vastly larger volumes of wind, still further development was necessary in the matter of its lining. Within the last few years the constantly growing use of the Mesaba ores and of the difficulty reducible magnetites, as well as the very refractory Cuban ores, and the increased percentage of flue dust in the furnace burden, each brings its new problem not only to the blast furnace engineer, but to the producers of refractory material.

"In general, it may be stated that the problem involves three factors, or some combination of these factors, the inclusion of extreme heat as one being, of course, axiomatical, while besides this, there is the factor of chemical action, as well as mechanical or physical abrasion. In any given problem there may be but one, two or all three of these factors."

In the blast furnace the temperature ranges from 400 to 600 degrees F. at the top to 3,500 degrees F. opposite the tuyeres. The chemical factor is one about which comparatively little is known and which offers a wide field for further investigation. One theory offered to account for the fluxing of linings is that cyanogen formed by the action of nitrogen on incandescent coke unites with any sodium and potassium present; the resulting cyanides are reduced to carbonates as they pass upward in the furnace, and the alkaline carbonates act on the lining to form comparatively easily fusible silicates. There is, however, little real information on the subject.

Abrasion in the blast furnace is, of course, most severe at the top, though it has an important effect on the entire furnace shaft until very near the zone of fusion. The use of ores containing zinc, such as are peculiar to the Virginia fields, introduces a serious problem. The metallic zinc deposited from the zinc vapors in the more or less permeable lining causes enormous distortion of the furnace. A material is demanded which shall combine the properties of refractoriness, resistance to abrasion, and ability to withstand the action of zinc. Another problem is presented by the newest type of blast furnace with the so-called "thin" lining, in which only the highest grade of refractory, and that satisfactorily prepared, has any chance of giving proper results.

"In the hot-blast stove, not only must the brick withstand the high temperatures and repeated stresses caused by the changes in such temperatures, but also the markedly disintegrating action of the gases. It must also have proper physical strength to bear the weight of the superimposed mass of brickwork of 100 feet or more. The failure to solve this latter problem has, in one instance, resulted in the necessity of shoveling out the stove complete within a year, whereas the successful solution may mean from 14 to 15 years' run.

"Each year sees a constant increase in by-product coke oven construction. Its development is bringing up new problems. The refractories originally deemed entirely satisfactory have since been discarded by all advanced designers, and new refractories capable of withstanding higher heats and with much greater conductivity are employed. The question of minimum expansion or contraction is here an all important one, as well as the ability to withstand abrasion. The beehive oven, comparatively simple as its questions may seem, has seen and is seeing great progress as well. As a rule, the materials once employed are by no means satisfactory when viewed from the modern economic operating standpoint. This is particularly true with the use of the high volatile coals such as occur in the Klondike and other regions.

"Connected with this problem of beehive refractories is that of waste heat flue construction. Experiments have been conducted along these lines for a number of years, and with one of the largest coke oven operations in this country had come to such a pass that, regardless of the large saving, the feasibility of the whole scheme depended on the finding of a suitable fire brick or silica brick which should withstand the intense heats encountered in the underground flues and at the same time avoid any difficulty from spawling. This question has apparently been satisfactorily solved, and marked economics can be looked for in its adoption.

"In the rotary cement kiln, the lining of which has to withstand not only the high heats and the abrasion of its charge, but the chemical action of the highly heated basic cement clinker, there are introduced secondary problems by no means unimportant in every change of mix. It is, of course, the aim that the lining should have such mechanical and chemical characteristics as shall enable it to pick up and hold a coating of clinker. Otherwise, the fire brick itself would be rapidly destroyed.

"In the ever recurring problem of maximum production at minimum cost, the aim has been to secure in retort gas house practice, material which shall give much longer life than the old clay retorts, shall withstand higher heats and shall have increased conductivity, so that the gasifying of the coal may be done in a shorter time and at decreased fuel consumption. The results of recent tests show this problem is in at least a very fair way of solution.

"Although in general the type of refractories used in open hearth work has seen little change, there is constantly the search for fire clay, silica, magnesia and chrome brick which shall give even a longer life, and the relative importance of refractories in this phase of the steel industry can be readily appreciated. The development of the electric furnace is the occasion of much research for refractories peculiarly adapted to its needs, and although the silica and magnesia brick in use in the open hearth are now employed, there is a search for other materials, should they be available.

"The question of a satisfactory retort for the distillation of zinc is as yet by no means solved. So near the temperature of fusion of the retort is it necessary to carry the heats in order to secure the volatilization of the zinc that there is but the narrowest factor of safety, and thus far, the effect of the various oxides is such as to preclude the use of certain refractories which otherwise might give good results. Much experimentation is going on, with the idea of lining clay retorts with chrome, but it is as yet too early to predict the final outcome.

"Enormous developments bid fair soon to occur in certain types of calcining kilns, these kilns making available deposits of iron ore which were formerly, due to the high sulphur content, not economical to roast. In the particular type of kiln in mind, there is the introduction of a muffle by which the sulphur gases are kept separate from the combustion gases, and are employed in the manufacture of sulphuric acid. Here the great conductivity of magnesite is the essential.

"In addition to the three factors which in general we have already considered, there is yet a fourth which we may term the personal equation and which is yet a most vital factor, that is, the treatment which the refractory receives at the hands of the user. In the same type of furnace a given refractory may give excellent results while operated by one, but be a complete failure in the hands of another. Knowledge and care in the operation of the furnace is all-important.

"There is yet another problem which we have not mentioned, and that is, the problem of the education of the user of refractories to an appreciation of what quality means and to a realization that cost must be figured on a tonnage output and not on the original price per thousand. In numberless instances the solution of refractory problems is but a question of bringing the consumer to realize that there is at hand a remedy for his troubles, if he will but accept it.

"That the progressive manufacturer is seeking to the best of his ability, a solution of these problems, is evidenced by the increasing amounts expended for research along all lines which may seem to bear upon it, and the discussion of these problems in the literature of to-day is undoubtedly having a great and beneficial effect. Undoubtedly one reason for the comparatively slow adoption, by the consumer, of certain grades of fire brick and silica brick, has been due to the lack of information of the manufacturer as to the exact conditions to be fulfilled. This has been due, in a measure, possibly, to a lack of initiative on the part of the latter and also to a mistaken policy of secrecy on the part of the former, but this is passing and there is coming to be a full realization that only by the heartiest co-operation and exchange of ideas can there be an efficient and satisfactory solution of the problems."

THE OIL SHALES OF EASTERN CANADA.

A REPORT OF AN INVESTIGATION OF THEIR ECONOMIC POSSIBILITIES.

R. W. Ells—Canadian Department of Mines.

THE utilization of bituminous shales for the production of illuminating and lubricating oils, paraffin, ammonium sulphate and other chemical products is an industry which still persists only in Scotland. The Scottish oil industry dates from 1848, when a small spring of petroleum was found in a coal mine in Derbyshire. After the failure of this supply, within a few months of its discovery, the distillation of crude oil from bituminous coal was attempted, but experiments with bituminous coals were abandoned on the discovery in 1850 of the Torbanehill mineral, a cannel coal yielding over 6 per cent. of volatile matter. The utilization of oil shales began in 1862, when the torbanite deposits were exhausted.

The history of the oil-shale industry is one of a constant series of improvements in the process of extracting the crude oil and of its subsequent fractional distillation. Financially, however, the industry has not been continuously successful. Ammonium sulphate is now one of the leading by-products and one of the principal sources of profit from the distillation of oil shales. The wide fluctuations in the market price of this material have from time to time threatened the industry with extinction, but at the present prices of ammonium sulphate and the other products of oil-shale distillation, the condition of the industry is one of prosperity. The number of active companies has declined from 51 in 1871 to 6 in 1906, but in spite of this reduction, the output has not decreased. The total production in 1906, 2,545,582 tons, yielded:

Naphtha	2,500,000	gallons
Illuminating oils	17,000,000	"
Gas oils	38,000	tons
Lubricating oils	40,000	"
Solid paraffin	22,500	"
Ammonium sulphate	50,000	"
Still coke	5,000	"

In 1907, the production of shale amounted to 2,775,799 tons; the average yield of crude oil was 23 gallons per ton. The most important company pays dividends of 50 per cent. on the invested capital; one paid during 1906, 2½ per cent., another, 6 per cent., and the remaining three companies, 15 per cent.

Extensive beds of bituminous shales occur in various localities in New Brunswick and Nova Scotia. Large sums of money have been spent in attempts to establish a mineral-oil industry in these provinces, particularly in connection with the so-called Albert shales of Albert and Westmoreland counties, New Brunswick, but none of these ventures has succeeded in placing the industry on a commercial basis. Encouraged by the success of the industry in Scotland, however, the leading company interested in the oil shales of New Brunswick has had tested in one of the Scotch works a consignment of 45 tons of shale mined during the winter of 1907-8 from one of the bands in Albert County. The tests were made under the supervision of a representative of the Canadian Department of Mines and an exhaustive report, written by Dr. R. W. Ells, has now appeared. The monograph covers not only the results of these trials and the geology and economic possibilities of the oil shales of Eastern Canada, but gives also a comprehensive review of the history and technology of the Scottish oil-shale industry. We are concerned here, however, only with Dr. Ells' conclusions as to the commercial value of the Canadian deposits.

The average yield of the shale tested in Scotland was 40.09 Imperial gallons of crude oil, and 76.94 pounds of sulphate of ammonia, per ton. The yield of both these materials was superior to that of the greater part of the Scottish shales and the behavior of the Canadian material in the retort was entirely satisfactory. Fractioning of the crude oil was done by two methods, the results of which were as follows:

Product.	Method A.	Method B.
	Quantites in gallons per 100 gallons of crude oil	
Heavy naphtha	1.62	1.45
Illuminating oils	10.04	11.50
Gas oil	14.87	13.04
Cleaning oil	2.83	1.56
Lubricating oil	9.58	11.03
Crude wax	2.26	2.21
" "	0.93	0.60
" "	....	0.16
Residuum from blue oil (refined)	0.28	0.57
Residuum from treated crude distillate (refined)	1.27	1.95
	43.68	47.07

Analyses of shales from various localities in New Brunswick show contents varying from 30 Imperial gallons of crude oil and 75 pounds of ammonium sulphate, to 54 gallons of crude oil and 110 pounds of ammonium sulphate, per ton. At prevailing prices the values of these products in the shales analyzed vary from $3.04 to $4.81 per ton. The value of the crude oil and ammonium sulphate in the shale tested in Scotland in 1908 would be $3.43 per ton. The cost of mining, retorting and manufacturing the ammonium sulphate averages in Scotch practice about $1.86 per ton. The cost of a complete plant of 180 retorts, with a capacity of 700 to 750 tons per day, is estimated at about $400,000. It appears from these data that the possibilities of profitable exploitation are very promising. Dr. Ells believes, however, that the production of only crude oil and ammonium sulphate should be attempted. "It is doubtful," he says, "if at the present time an expensive plant for the manufacture of refined oils, paraffins, naphthas, etc., on a large scale, would, in the face of possible competition and hostility on the part of the Standard Oil Company, be sufficiently profitable to warrant the necessary expenditure of capital in this part of the proposed enterprise."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering..............Page 435
Electrical Engineering......... " 445
Industrial Economy............ " 451
Marine and Naval Engineering. " 452
Mechanical Engineering........Page 455
Mining and Metallurgy........ " 465
Railway Engineering........... " 472
Street and Electric Railways.. " 476

CIVIL ENGINEERING.

BRIDGES.

Arches.

The Elastic Arch. Dean Galbraith. Deals with the theory of the graphical method commonly used in connection with the design and computation of the elastic arch, 2800 w. Ap Sci—March, 1910. No. 13212 C.

The Calculation of Arches (Berechnung von eingespannten Gewölben). A. Burghardt. Mathematical discussion of methods of stress determination. Ills. 2500 w. Beton u Eisen—March 14, 1910. No. 13504 F.

Bascule.

Electrical Operation of Eight-Track Lift Bridge. Illustrated description of a bridge nearing completion over the Chicago Drainage Canal, at 31st St., Chicago. 1500 w. Elec Wld—April 14, 1910. No. 13094.

Boston.

The Charles River Bridges. Charles W. Killam. A critical discussion of the structures now crossing this river, the need of replacing some of them, and the importance of considering beauty in the designs. Ills. 2000 w. Harvard Engng Jour—April, 1910. No. 13547 D.

Clearances.

Bridges Over Navigable Streams. The Interference of Water Traffic with Land Traffic. Editorial comment, and review of the situation at Pittsburg, with letter from Edwin K. Morris. 3000 w. Eng News—April 14, 1910. No. 13105.

Concrete.

An Analysis of Concrete Bridge Failures. C. R. Young. Read before the Can. Cement & Concrete Assn. Gives information collected in regard to such failures, with a view to determining the suitability of concrete for strong and enduring engineering works. Ills. 4000 w. Engng-Con—April 13, 1910. No. 13088.

Failures.

The Failure of the Pugh Ford Arch Bridge. Correspondence relating to the reinforced-concrete arch highway bridge in Indiana which was wrecked by the erosion of foundations. 3000 w. Eng News—April 21, 1910. No. 13263.

See also Concrete, under BRIDGES.

Floors.

See Reconstruction, under BRIDGES.

Masonry.

A Fine Long-Span Masonry Arch Bridge. Illustrated description of a structure in France, having a main span of 262 ft. 9½ ins., with the keystone about 217 ft. above the level of the water. Also the methods of erection. 900 w. Sci Am—April 9, 1910. No. 12981.

Piers.

Pneumatic Caisson Piers in Alaska. Illustrates and describes work carried out under very unusual and extremely difficult conditions in connection with railway construction. 3500 w. Eng Rec—April 23, 1910. No. 13427.

The Passyunk Avenue Bridge Piers. Illustrated description of the construction of the piers for a highway bridge across the Schuylkill River, at Philadelphia. It is a steel superstructure resting on 11 piers and one abutment. 2500 w. Eng Rec—April 2, 1910. No. 12829.

Piers of the Penhorn Creek Railroad Viaduct. Illustration and description of work on the Erie R. R., at Jersey City, where deep foundations in wet soil were required. 1500 w. Eng Rec—April 2, 1910. No. 12834.

Substructure of a Bridge Over the Zijl Near Leiderdorp on Holland Electric Railway (De Onderbouw eener Brug over de Zijl nabij Leiderdorp in den Hollandschen Elektrischen Spoorweg). J. W. Maas. Illustrated description of the foundations and their construction 2000 w. De Ingenieur—March 12, 1910. No. 13523 D.

Reconstruction.

Report on the Question of the Strengthening of Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains (Subject II, Littera B, for Discussion at the Eighth Session of the Railway Congress). Mr. Labes. Considers the suitable strengthening of existing metal bridges proportionately to the increase in weight of the locomotives and in the speed of the trains. Ills. 21000 w. Bul Int Ry Cong—Jan., 1910. No. 13603 G.

Widening Piney Creek Bridge, Washington. Illustrated description of the construction of a duplicate of a previously completed bridge, and connecting the two with a reinforced concrete platform making a wide roadway. 1500 w. Eng Rec—April 2, 1910. No. 12850.

Widening the Floor of a Double-Track Masonry Viaduct. Brief illustrated description of work on St. Florent viaduct, Paris & Orleans Ry. (France), and the addition of a third track. 900 w. Eng News—April 14, 1910. No. 13103.

Reinforced Concrete.

Building a Concrete Bridge from an Existing Structure. Illustrated description of work at Bethlehem, Pa., replacing a steel bridge with a reinforced-concrete arch bridge. 1800 w. Eng Rec—April 23, 1910. No. 13428.

A Concrete Girder Bridge with Curved Bottom Chord. Illustrates and describes a reinforced-concrete bridge soon to be built at Ocean City, N. J. 1200 w. Eng Rec—April 9, 1910. No. 12986.

The East Olive Avenue Bridge in Spokane, Wash. Illustrated description of the construction of a 5-span reinforced concrete bridge, 565 ft. long, over the Spokane River. 2500 w. Eng Rec—April 2, 1910. No. 12838.

Erection of Florida East Coast Railway Bridges. Describes the location and conditions, the methods adopted, and the damage by a hurricane which caused the canceling of the contract. Ills. 2000 w. Eng Rec—April 2, 1910. No. 12832.

Steel.

Erection of the Slatington Bridge. A new bridge of 14 deck plate girder spans on the Lehigh & New England Ry., in Pennsylvania, is illustrated and described. 2500 w. Eng Rec—April 2, 1910. No. 12854.

Steel Railway and Highway Bridges of the Province of Alberta. J. C. Chalmers. Abridged from a paper read before the Edmonton Engng. Soc. Illustrates and describes types of steel bridges and their substructures. 5400 w. Can Engr—April 1, 1910. No. 12906.

A Steel Arch Bridge in the Province of Yun Nan, French China. Illustrated description of the design and erection of bridges in a rugged country, where the work must be done by poor labor. Translated from *Le Génie Civil.* 1200 w. Eng News—April 21, 1910. No. 13259.

The Vistule Steel Viaduct (Le Viaduc métallique sur la Vistule à Marienwerder, Prusse orientale). Illustrated description of a steel structure, 1058 metres long, at Marienwerder, eastern Prussia. 3000 w. Génie Civil—March 5, 1910. No. 13335 D.

Swing Bridges.

Experiments on a Test Pivot for the Caronte Swing Bridge (Expériences sur le Pivot d'Essai du Pont tournant sur l'Etang de Caronte). E. Chartiée and G. Blot. Reports results of experiments made in designing the pivot of a swing bridge of very heavy weight. Ills. 12000 w. Rev Gen d Chemins de Fer—March, 1910. No. 13321 G.

Trestles.

A Five-Mile Trestle Across Albemarle Sound, Norfolk & Southern Ry. Illustrated detailed description of the location, design, construction and operation of this notable timber structure. 1200 w. Eng News—April 21, 1910. No. 13255.

Viaducts.

Different Methods of Erecting Steel Viaducts. Frank W. Skinner. Illustrated detailed description of work of this character as carried out in various places in the United States and Canada. 1600 w. Eng Rec—April 2, 1910. No. 12843.

The Erection of Tinkers Creek Viaduct. Illustrates and describes the erection of a double-track plate-girder structure about 1300 ft. long and 161 ft. high from tops of piers to base of rail, on the

The Construction of the Fades Viaduct (Note sur la Construction du Viaduc des Fades). M. Virard. Detailed description of the erection of a steel structure 470 metres long. Ills. 24000 w. Ann d Ponts et Chaussées—1910-I. No. 13306 E + F.

L. Erie & Pittsburg Ry. 2000 w. Eng Rec—April 2, 1910. No. 12828.

CONSTRUCTION.

Beams.

The Strength of Beams of Channel Section (Versuche über die tatsächliche Widerstandsfähigkeit von Trägern mit [-förmigem Querschnitt). C. Bach. A report of tests. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—March 5, 1910. No. 13509 D.

Boring.

Core Drilling Under the Hudson River for the Catskill Aqueduct. William E. Swift. Describes the methods of vertical drilling from scows anchored in the river, the sinking of a test shaft, and work as finally carried on. 2000 w. Eng News—April 7, 1910. No. 13003.

Columns.

The Design of Columns with Two Parts of Different Section (Sul Calcolo dei Pilastri formati da due Tronchi di diversa Sezione). A. Danusso. Mathematical. Ills. 3000 w. Il Cemento—March 15, 1910. No. 13351 D

Concrete.

A Craftsman's Concrete House at Glencoe, Ill. Illustrated description of the design and construction. 2500 w. Cement Age—April, 1910. No. 13434.

Concrete Building Construction of Separately Molded Members and Its Cost. Extracts from a paper by Charles D. Watson read before the Nat. Assn. of Cement Users. Information concerning buildings constructed of unit concrete members, and their cost. Ills. 2500 w. Engng-Con—April 6, 1910. No. 12954.

Excavation.

A Giant Excavator. Illustrated description of what is believed to be the largest steam crane excavator in existence. 2000 w. Engr, Lond—April 15, 1910. No. 13472 A.

Hydraulic Excavation in the Pacific Division of the Panama Canal. Gives an outline of conditions and the character of the work, describing preliminary work and the plant for the hydraulic work and its operation. Ills. 3500 w. Eng Rec—April 2, 1910. No. 12826.

See also Rock Removal, under WATERWAYS AND HARBORS.

Floors.

Bulb-Iron Floor in the Moldau Harbor Shed in Hamburg (Die Bulbeisendecke im Neubau des Schuppens am Moldauhafen zu Hamburg). G. Kaufmann. Describes floor construction 11,000 square metres in extent. Ills. Serial. 1st part. 4000 w. Beton u Eisen—March 14, 1910. No. 13503 F.

Foundations.

Prevention and Cure of Weak Foundations. Explains cases of weakness caused by changes in water level due to exposure of wood piling and recommends the use of concrete or other supports unaffected by changes in water level; and the use of strengthening of weak foundations by the sectional method of underpinning. 2500 w. Cement Age—April, 1910. No. 13432.

Deep Foundation Construction in an Occupied Building. Illustrates and describes methods used in a bank building of New York City, to furnish reliable foundations for a concrete and steel safe-deposit vault. 1000 w. Eng Rec—April 9, 1910. No. 12990.

Deep Pneumatic Foundations for New York Municipal Building. Illustrates and describes foundation work of a building 580 ft. high, located in the plaza at the Manhattan Terminal of the Brooklyn Bridge. 1800 w. Eng Rec—April 2, 1910. No. 12846.

"Compressol" System Foundations in Egypt (Gründungen mittels mechanischer Bodenverdichtungen "System Compressol" in Aegypten). Walther Stross. Describes various examples of foundation piling work on this system in the Nile Delta. Ills. 3200 w. Beton u Eisen—March 14, 1910. No. 13502 F.

Piling.

Concrete Piles. From the report of the Committee on Masonry, presented at the annual meeting of the American Railway Engineering and Maintenance of Wav Association. Considers types, their advantages, etc. 2500 w. Eng News—April 7, 1910. No. 13001.

Failure of Wooden Piling Due to Private Agencies and Methods of Prevention. W. Putnam. Read before the Nova Scotia Soc. of Civ. Engrs. Considers the insects and worms that destroy timber and the methods of preventing the ravages. 2000 w. Can Engr—April 22, 1910. No. 13438.

See also Foundations, under CONSTRUCTION.

Pipe Galleries.

See same title, under WATER SUPPLY.

Regulations.

Allowable Stresses in Iron (Die baupolizeilichen Beanspruchungsziffern von Eisen). An editorial discussion of new building regulations in Germany. 2200 w. Stahl u Eisen—March 16, 1910. No. 13359 D.

Reinforced Concrete.

Deflection in Reinforced-Concrete Structures and Its Consequences (Beitrag zur Durchbiegung von Eisenbetonkonstruktionen und Folgerungen hieraus). B. Pollnow. Mathematical. Ills. 4500 w. Beton u Eisen—March 14, 1910. No. 13505 F.

Specifications for Plain and Reinforced Concrete and Steel Reinforcement. Presented with report of the Committee on Masonry at the meeting of the Am. Ry. Engng. & Main. of Way Assn. 3000 w. Eng News—April 14, 1910. No. 13108.

A Storage Building for an Automobile Factory. Illustrated description of a reinforced-concrete warehouse at Buffalo, N. Y. 1500 w. Eng Rec—April 16, 1910. No. 13142.

New Automobile Plant of the D. P. Nichols Company, Boston. E. S. Larned. Illustrated detailed description of a reinforced concrete building at Cambridge, Mass. 2200 w. Cement Age—April, 1910. No. 13433.

Two Examples of Hospital Construction in Reinforced Concrete (Due Costruzioni Ospitaliere in Cemento armato). E. Sacerdote. Describes two structures in Rome, Italy. Ills. 2000 w. Ann d Soc d Ing e d Arch Ital—March 1, 1910. No. 13344 F.

See also Stacks, under CONSTRUCTION; Reservoirs, under WATER SUPPLY; and Locks, under WATERWAYS AND HARBORS.

Stacks.

Special Forms for and Methods of Constructing Weber Concrete Chimneys. Carl Weber. Rearranged from paper before the Am. Soc. of Engng.-Con. Illustrated description of construction methods. 2500 w. Engng-Con—April 20, 1910. No. 13401.

Steel.

The Design of a Plate Girder. Martin Joachimson. An explanation by solving a stated problem. Supplement. 2500 w. Mach, N Y—April, 1910. No. 12898 C.

Stress Variation on the Section of an Angle in Tension. Charles J. Tilden. An account of an experimental study of stress distribution in angles under tension. Ills. 2000 w. Harvard Engng Jour—April, 1910. No. 13548 D.

Steel-Frame Buildings at Gary, Indiana. Illustrates and describes some details of the large steel-frame industrial buildings of the new plant of the Indiana Steel Co. 2000 w. Eng Rec—April 9, 1910. No. 12988.

Erection of Steel Frame Buildings at Gary, Ind. Illustrates and describes methods of construction for unusually large buildings. 1800 w. Eng Rec—April 23, 1910. No. 13422.

Improving the Seventh Regiment Armory, New York. Describes extensions and rearrangements amounting almost to reconstruction, at an estimated cost of about $200,000. 3000 w. Eng Rec—April 2, 1910. No. 12839.

Forest Hills Terminal, Boston Elevated Railway. Illustrated description of a station designed with special considerations to harmonious relations with the surroundings. The steel framework is covered by a reinforced-concrete shell. 1600 w. Eng Rec—April 9, 1910. No. 12989.

Tunnel Lining.

Tunnel Lining, Chicago, Milwaukee & Puget Sound Railway. Illustrates and describes methods used in lining tunnels driven through rotten granite formations. 2000 w. Eng Rec—April 2, 1910. No. 12831.

Tunnels.

Tunnels in Being and Tunnels to Come. Discusses the length, elevation, cost, etc., of famous mountain tunnels. 1200 w. Sci Am Sup—April 23, 1910. No. 13270.

Some Features of the Alignment Work on the Pennsylvania Tunnels. Francis Mason. Outlines the more important methods adopted on the East River Division. Ills. 4000 w. Harvard Engng Jour—April, 1910. No. 13540 D.

Some Engineering Features of the Detroit River Tunnel. Gives an outline of the scheme and illustrates and describes the interesting features of engineering that developed in carrying it to completion. 4000 w. Ry Age Gaz—April 29, 1910. No. 13508.

Method of Reconstructing the Washington Street Tunnel of the Chicago Railways Company; a New and Economical Method of Constructing Tunnels. Illustrates and describes the reconstruction. 2500 w. Engng Con—April 20, 1910. No. 13402

Section 1 of the Washington Street Tunnel, Chicago. Illustrated description of underpinning and invert construction made necessary by the deepening of the Chicago River, under which this street railway tunnel passes. The conditions are very difficult. 2500 w. Eng Rec—April 2, 1910. No. 12835.

The Wallkill Pressure Tunnel of the Catskill Aqueduct. Illustrates and describes the construction of the Wallkill siphon, a part of the distribution system of the Catskill water supply. It is a circular concrete lined tunnel 23,391 ft. long and 14 ft. 6 in. inside diameter, with 6 shafts ranging in depth from 350 to 480 ft. 6000 w. Eng Rec—April 2, 1910. No. 12847.

The Laramie Tunnel. R. L. Herrick. Brief illustrated description of the methods of construction, and matters of related interest. 1800 w. Mines & Min—April, 1910. No. 12865 C.

The Hunters Brook Tunnel Construction. Describes the construction plant and work on this horse-shoe shape tunnel of the N. Y. water supply. 3000 w. Eng Rec—April 2, 1910. No. 12848.

Warehouses.

Warehouses. Charles H. Patton. An illustrated discussion of their planning and construction. 3500 w. Archt Rec—April, 1910. No. 13069 C.

MATERIALS OF CONSTRUCTION.

Cement Tile.

Some Experiments on the Cost and Durability of Cement Drain Tile. W. H. Day. Read before the Can. Cement & Concrete Assn. Reports mine experiments and the results. 2500 w. Engng-Con—April 13, 1910. No. 13087.

Concrete.

The Action of Frost on Hydraulic Cements — Concreting During Freezing Weather. Alfred E. Uren. An outline of investigations made in this field. 3000 w. Ap Sci—March, 1910. No. 13217 C.

Reinforced Concrete.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Pétersbourg en 1908). A report of the discussion on the application of reinforced concrete to the construction of marine works. Ills. 25000 w. Ann d Ponts et Chaussées—1910-I. No. 13309 E + F.

Stone.

The Physical Properties of Building Material. William Ralph Baldwin Wiseman and Owen Williams Griffith. A report of experimental investigations, with conclusions. 5600 w. Inst of Civ Engrs—No. 3850. No. 13273 N.

Structural Materials.

Present-Day Needs in Structural Materials. Discussion of the needs in Road Materials, by S. D. Foster; in Refractory Materials, by Kenneth Seaver; Fire Proofing Problems, by C. B. Asher; Timber, by E. F. Wendt; Steel, by R. B. Wordworth and others. Ills. 15500 w. Pro Engrs' Soc of W Penn—April, 1910. No. 13431 D.

Timber Preservation.

Preservatives for Wood Paving Blocks. Charles N. Forrest. Data and information concerning the adoption of tar in lieu of creosote oil. 1500 w. Eng Rec—April 16, 1910. No. 13140.

MEASUREMENT.

Cement Testing.

Notes on the Le Chatelier Boiling Test of Portland Cement. D. B. Butler. Abstract of a paper read before the Concrete Inst. 1800 w. Surveyor—March 25, 1910. No. 12928 A.

Hydrographic Surveying.

The Mille Lac Lake Survey, Minnesota; Methods and Costs. Robert Follansbee. An account of a survey made in connection with an investigation of the state's water resources. 1000 w. Eng News—April 7, 1910. No. 12998.

Stream Gauging.

A Comparison of Stream Discharge Indicated by Current Meter and by Weir Formulas, Yakima River, Washington. J. C. Stevens. Gives interesting comparison of results secured with a current meter and those obtained by a formula for an overflow dam. Ills. 700 w. Eng News—April 28, 1910. No. 13567.

River Gauging with Rod Floats. George W. Brown. Details of a method of stream gauging by use of rod floats, with an outline of the reductions. 2500 w. Wis Engr— April, 1910. No. 13200 D.

Surveying.

History of the Ordnance Survey. J. J. Amos. Describes methods used in work carried out by the British Government. 4500 w. Surveyor—March 25, 1910. No. 12927 A.

Tests of Simple and Inexpensive Surveying Instruments. John T. Stewart. Abstract of paper read before the Ill. Soc. of Engrs. & Surv. A report of experiments carried out to determine the value of such instruments. 2500 w. Eng News—April 21, 1910. No. 13257.

The Stadia and Stadia Surveying. E. M. Douglas. Suggestions for careful stadia work, explaining the usefulness of this device. 3500 w. Eng News—April 28, 1910. No. 13569.

Plotting Co-ordinate Surveys. J. J. Bristol. Describes graduated triangles for plotting co-ordinates, explaining their use. 1500 w. Min & Sci Pr—April 2, 1910. Serial. 1st part. No. 12969.

MUNICIPAL.

City Planning.

The Planning of Towns and Suburbs. Raymond Unwin. An illustrated study of the principles governing the planning and arrangement. 4500 w. Jour Roy Inst of Brit Archts—March 5, 1910. No. 12918 B.

Market Buildings.

Municipal Markets of St. Louis. Charles Claude Casey. Illustrates and describes structural features, sanitation and refrigeration, etc. 3500 w. Munic Jour & Engr—April 27, 1910. No. 13489.

Pavements.

Average Unit Prices and Some Details of Pavements Constructed in 1909 in a Number of Representative American Cities. 3000 w. Engng-Con—April 6, 1910. No. 12955.

Specifications for Bituminous Concrete Pavement. Report of committee of the Organization for Standardizing Pavement Specifications. 2000 w. Munic Engng—April, 1910. No. 13222 C.

Specifications for Concrete Sidewalks, Curbs and Gutters and Pavements. Report of committee of the Organization for Standardizing Paving Specifications. 1500 w. Munic Engng—April, 1910. No. 13223 C.

Specifications for Sheet Asphalt Pavement. Report of the asphalt committee of the Organization for Standardizing Paving Specifications. 2500 w. Munic Engng—April, 1910. No. 13221 C.

Tramway Margins. J. S. Killick. The difficulties in the maintenance of tramway margins, particularly the joint between a paved track and a macadam road, are discussed. 1500 w. Surveyor—April 15, 1910. No. 13448 A.

See also Timber Preservation, under MATERIALS OF CONSTRUCTION; and Streets, under MUNICIPAL.

Public Baths.

New Public Baths at Hinckley. Illustrates and describes details of construction. 900 w. Surveyor—April 1, 1910. No. 13049 A.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Discusses the usual methods of disposal of house refuse. 2500 w. Munic Engng—April, 1910. No. 13220 C.

High Temperature Garbage and Refuse Destructors. Col. W. F. Morse. Read before the Am. Soc. of Munic. Imp. Presents the advantages of the destructor system as compared with the crematory system. 3000 w. Munic Engng—April, 1910. No. 13227 C.

Roads.

Public Roads and Vicinal Railways. R. O. Wynne-Roberts. Shows how railways on public roads promote the development of rural districts and assist in road improvements. 6000 w. Surveyor—April 15, 1910. No. 13451 A.

Sand-Clay and Earth Roads in the Middle West. W. L. Spoon. Information concerning the methods and experimenal roads constructed by the Office of Public Roads. Discusses the soil conditions in different localities, describing the road improvement applicable to each. Ills. 9500 w. U S Dept of Agri, Circ. No. 91—March 19, 1910. No. 12957 N.

Sand-Clay Roads in the Middle West. Extracts from a circular by W. L. Spoon, giving an account of materials and methods of construction. 3000 w. Eng Rec—April 16, 1910. No. 13136.

Report on the First International Road Congress. P. C. Cowan. Report to the Local Government Board of Ireland 3500 w. Surveyor—April 15, 1910. Serial. 1st part. No. 13452 A.

Irish Roads. Answers from county surveyors, to questions relating to construction, maintenance and administration. 4000 w. Surveyor—April 15, 1910. Serial. 1st part. No. 13453 A.

Modern Conditions Affecting the Road Engineer. W. H. Maxwell. Discusses the increase and change in character of the traffic, and the problems due to it. 2500 w. Surveyor—April 15, 1910. No. 13450 A.

Roads and Vehicles. Col. R. E. Crompton. Discusses the future of road engineering, the construction, maintenance and improvements in wheel construction. 2200 w. Surveyor—April 15, 1910. No. 13446 A.

The Other Half of the Automobile. Discusses the importance of the roadbed upon car performance, the damage to roads by automobiles, and the improvements needed. Ills. 1800 w. Automobile—April 21, 1910. No. 13202.

Modern Road Repairs. E. Purnell Hooley. Compares the wearing qualities of waterbound and waterproof roads, and considers in detail the construction of a Tarmac road. 2000 w. Surveyor—April 15, 1910. No. 13447 A.

Best Means of Dustproofing the Highway. Marius C. Krarup. A review of present information on this subject, concluding that the problem is not yet satisfactorily solved. 2000 w. Automobile—April 28, 1910. Serial. 1st part. No. 13570.

Experimental Work of the New York State Highway Commission in 1909 with Glutrin, and with Resurfacing with Bituminous Macadam and Asphalt Macadam. Notes from recent report of the N. Y. State Highway Commission describing the experimental work carried out. 4000 w. Engng-Con—April 13, 1910. No. 13080.

Methods of a New York State Commission of Highways in Testing Bituminous Materials Used in Road Work. Also Road Surface Treatment with Oil in 1909. 3000 w. Engng Con—April 27, 1910. No. 13550.

The Use of Tar on Roads. W. J. Atkinson Butterfield. Deals with the properties of tars as regards their suitability for road work. 2000 w. Surveyor—April 15, 1910. No. 13445 A.

Tar-Macadam Roads. F. E. Newberry. Read at meeting of the Illinois Gas Assn. Argument favoring tar-macadam and showing its advantage in cost and durability. Ills. 3000 w. Pro Age—April 1, 1910. No. 12810.

Tar Treatment of Roads. P. P. Sharples. Read at meeting of the Illinois Gas Assn. Outlines the modern use of tar in treatment of roads. Discussion. 3500 w. Pro Age—April 1, 1910. No. 12811.

Tar as Applied to the Surface Treatment of Roads. Harvey J. Skinner. Read at meeting of the Am. Gas Inst. Discusses the wear of roads due to change in traffic, the methods of applying tar and matters related. Discussion. 6000 w. Pro Age—April 1, 1910. No. 12812.

Asphaltic Oil Treatment of Macadam Roads. Charles H. Bartlett. Discusses methods and quality of oil, for the preservation of road surfaces, and elimination of dust. 4000 w. Jour Assn of Engng Socs—Feb., 1910. No. 12963 C.

Sewage Disposal.

Sewage and Sewage Effluents. John C. Thresh. Lecture before the Assn. of Mgrs. of Sewage Disposal Works. Interpretation of the results of analyses. 3500 w. Surveyor—April 1, 1910. Serial. 1st part. No. 13050 A.

Notes on the Proposed Sewage Disposal Plant for Gloversville, N. Y. Morrell Vrooman. Outlines the nature, dimensions, and capacity of the various parts of the plant and the proposed method of operation. The sewage contains a large amount of tannery wastes. 1000 w. Eng News—April 28, 1910. No. 13568.

The Sewage Disposal Plant at Roebling. Outlines the conditions, and describes in detail the systems of sewerage and the methods of disposal. Ills. 4000 w. Eng Rec—April 9, 1910. No. 12985.

New Sewage Pumping Station at Glasgow. Illustrated description of the station at Kinning Park, Glasgow, in connection with the purification of the river Clyde. 2000 w. Engr, Lond—April 8, 1910. No. 13170.

Mechanical Sewage Purification Plants (Maschinelle Abwasser-Reinigungs-Anlagen). Herr Wurl. Describes a number of plants in Germany. Ills. 7000 w. Glasers Ann—March 15, 1910. No. 13396 D.

Sewer Cleaning.

Sewer Cleaning in Brooklyn. Describes the methods adopted. 1000 w. Eng Rec—April 2, 1910. No. 12855.

Sewers.

Constructing Concrete Sewers in Open Trench. Describes work in progress on Staten Island. Ills. 1500 w. Eng Rec—April 16, 1910. No. 13135.

Constructing a Large Brick-Lined Sewer Tunnel, Brooklyn, N. Y. Illustrated detailed description of the construction of a sewer having an internal diameter of 138 inches. 3000 w. Eng Rec—April 9, 1910. No. 12987.

Cost of Sewer, Muskoka, Ont. E. A. James. Gives details of a sewer having 550 ft. in granite rock, 9 ft. deep. 500 w. Ap Sci—March, 1910. No. 13215 C.

Construction Methods on the Louisville Sewerage Work. Illustrated description of methods used on extensive sewerage improvements. 2800 w. Eng Rec—April 2, 1910. No. 12851.

The Southern Outfall Sewer, Louisville, Ky. William Mayo Venable. Illustrated description of the largest trunk sewer of the extensive system under construction. It is of reinforced concrete. 1200 w. Eng Rec—April 2, 1910. No. 12852.

Intercepting Sewer at Elizabeth, N. J. Illustrated description of a sewer to prevent the pollution of Elizabeth River. Siphon river crossings, coffer dam construction, methods of excavating, etc., are described. 3000 w. Munic Jour & Engr—April 6, 1910. No. 12917.

Sidewalks.

See Pavements, under MUNICIPAL.

Stone Crushing.

New Crushing Plants of the Casparis Stone Company. Illustrates and describes the two largest crushing plants yet designed, located at Havre de Grace, Md., and Patterson Creek, W. Va. 2000 w. Eng Rec—April 2, 1910. No. 12845.

Street Cleaning.

Tests of Street Flushing or Washing Machines, Department of Street Cleaning, New York City. E. D. Very. Describes flushing tests made, giving summary of tests of six machines. 1500 w. Eng News—April 14, 1910. No. 13099.

Streets.

The Dimensions of Roads and Streets. H. Percy Boulnois. Discusses relative widths of footways and roadways. 2500 w. Surveyor—April 15, 1910. No. 13444.

WATER SUPPLY.

Aqueducts.

See Tunnels, under CONSTRUCTION.

Artesian.

See Wells, under WATER SUPPLY.

Baltimore, Md.

A Proposed Enlargement of the Water-Supply of Baltimore, Md. Alfred M. Quick. Reviews the general features of the present supply system and gives the general conclusions and recommendations of the consulting engineers. 2200 w. Eng News—April 21, 1910. No. 13264.

Dams.

Failure of an Earth Dam with Concrete Core Wall, at Erindale, Ontario. Francis F. Longley. An illustrated account of a dam that failed during construction. 1000 w. Eng News—April 14, 1910. No. 13106.

Construction of the Belle Fourche Dam. O. T. Ready. Illustrated description of the construction of a dam in South Dakota, to store the flood waters for use in irrigation. 4500 w. Eng Rec—April 2, 1910. No. 12853.

The Hume Lake Multiple Arch Dam. Gives the principles of design and methods of construction of a type of masonry dam new to the United States. It is on Ten Mile Creek, California, and was recently completed. Ills. 7000 w. Cal Jour of Tech—March, 1910. No. 13073.

The Salmon River Dam and Irrigation Project, Idaho. Illustrated detailed description of the construction of a dam to develop the reservoir site. It crosses a deep narrow canyon worn through the rock by the river. The equipment for the work is also described. 5500 w. Eng Rec—April 2, 1910. No. 12840.

Designs and Contract for Rebuilding the Colorado River Dam at Austin, Texas. Reviews the previous history of this dam, and gives a summary of the terms of the contract for its rebuilding. Ills. 3000 w. Eng News—April 14, 1910. No. 13107.

The St. Andrew's Rapid Dam (Das Wehr in den St. Andrews-Stromschnellen). H. P. Borden. Describes the construction of this important work in Manitoba. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—March 12, 1910. No. 13510 D.

Disinfection.

The Growing Use of Hypochlorites of Sodium and Calcium as Water Disinfectants. Editorial, and six articles by George Reyer, J. A. Jensen, W. R. Gelston, Ermon M. Peck, and others. Ills. 12500 w. Eng News—April 7, 1910. No. 12999.

Filtration.

Sand Filters and Disease Germs. Rudolph Hering. Discusses the passage of pathogenic bacteria through sand filters. 2000 w. Munic Jour & Engr—April 27, 1910. No. 13400.

The Cleansing of Filtering Media. A. B. Ogden. Read before the Inst. of San. Engrs. Considers the cleansing of media which has been used in filtration, and the cost. 2000 w. Surveyor—April 8, 1910. No. 13160 A.

The Slow Sand Water Filters under Construction at Reading, Pa. Mandes Golder. Plan and illustrated description of the Maiden Creek slow sand water filters now under construction. 3000 w. Eng News—April 14, 1910. No. 13100.

Reading Water Works Improvements. Illustrates and describes interesting filter and reservoir construction. 4000 w. Munic Jour & Engr—April 20, 1910. No. 13204.

A 10,000,000-Gal. Pressure Mechanical Water Filtration Plant at Duke's Farm, Somerville, N. J. George F. Hodkinson. Plan and description of a large filtration plant for purifying the water of Raritan River, for the supply of a beautiful country estate having many lakes, fountains, etc. 1500 w. Eng News—April 14, 1910. No. 13101.

Ground Waters.

See Water Works, under Water Supply.

India.

Water Supply in India. Percy G. Scott. Describes Moulmein, Burma, scheme and method of carrying out work in a tropical country. 3000 w. Surveyor—April 8, 1910. No. 13159 A.

Irrigation.

Irrigation and Engineering. D. A. Willey. An illustrated account of work of the United States Reclamation Service. 6500 w. Cassier's Mag—April, 1910. No. 13189 B.

Irrigation Legislation for the Philippine Islands. A. E. Chandler. An account of conditions, the legislation for the use and distribution of water formerly enacted, and that needed. 3500 w. Cal Jour of Tech—March, 1910. No. 13072.

Government Irrigation in the Yakima Watershed.—The Tieton Canyon Canal. Day Allen Willey. Brief illustrated description of the Tieton project, and the difficulties encountered. 1000 w. Sci Am—April 16, 1910. No. 13110.

Sun River Project, Montana; United States Reclamation Service. S. B. Robbins. Information concerning this project, the irrigation contemplated, cost, etc. 1500 w. Jour Assn of Engng Socs—Feb., 1910. No. 12964 C.

Concrete Chute in an Irrigation Canal. M. Nikolitch. Brief illustrated description of a chute and other canal works in the Imperial Valley. 1000 w. Eng Rec—April 23, 1910. No. 13426.

See also Electric Pumping, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Minnesota.

Water Resources Investigation in Minnesota. Robert Follansbee. Describes the work of investigating the water resources of this state. 3000 w. Cornell Civ Engr—April, 1910. No. 13546 C.

Ozone Treatment.

See Purification, under Water Supply.

Pipe Galleries.

New York City Pipe Galleries. Walter G. Turini. Brief illustrated description of the first pipe galleries built in the city, and the method of construction. 900 w. Munic Jour & Engr—April 13, 1910. No. 13079.

Pollution.

The Chances of Pollution in Shallow Wells for Municipal Water Supply. Charles B. Burdick. Abstract of paper before the Ill. Water Supply Assn. Notes on the sanitary character of well-water, referring particularly to shallow wells deriving their supply from sands and gravels. 2000 w. Eng News—April 21, 1910. No. 13206.

See also Construction Camps, under MISCELLANY.

Purification.

The Coagulating Plant of the St. Louis Water Works. Arthur J. Jacobs. Describes a plant where the process is strictly one of coagulation and sedimentation, no filters being used. 11800 w. Jour Assn of Engng Socs—March, 1910. No. 13528 C.

Water Purification and Pumping Plant at New Orleans, La. Illustrated detailed account of works put in operation about one year ago, for purifying the Mississippi River water before distributing. 6000 w. Eng Rec—April 23, 1910. No. 13421.

Drinking-Water Supply for Dwellings in Isolated Places. (Drinkwatervoorziening in het klein, voor Woningen ap afgelegen Orden). H. van Berckel. Describes devices for water purification on a small scale. Ills. 3500 w. De Ingenieur—March 19, 1910. No. 13524 D.

The Production and Utilization of Ozone with Especial Reference to Water Purification. Describes the development of various processes for the use of ozone as a disinfecting and bleaching agent, especially for purifying city water supplies. Also editorial. Ills. 13500 w. Eng News—April 28, 1910. No. 13572.

Ozone Sterilization of Water. Clifford D. Meeker. Explains the different forms of apparatus used, principles of action, effects of temperature and humidity and cost. Ills. 5000 w. Munic Jour & Engr—April 20, 1910. No. 13205.

Reservoirs.

Failure of a Reinforced Concrete Reservoir. Gives data regarding the failure of a service reservoir at Mittagong, N. S. W., taken from the report for 1909 of the Dept. of Pub. Works, N. S. W. 1500 w. Eng Rec—April 23, 1910. No. 13425.

An Earth Reservoir at Ogden, Utah. Illustrated description of a 13,000,000-gal. reservoir recently completed for the municipal water-supply system. 1500 w. Eng Rec—April 16, 1910. No. 13137.

The Construction of a Reinforced Concrete Reservoir of One Million Gallons Capacity. H. F. Blomquist. Brief illustrated description of a structure for the city of New Ulm, Minn. 1200 w. Minn Engr—March, 1910. No. 13077 C.

See also Filtration, under WATER SUPPLY.

Sterilization.

Germicidal Effect of Mine Water and Tannery Wastes. A report of experimental investigations to determine their effect on certain micro-organisms. 2000 w. Eng Rec—April 16, 1910. No. 13141.

Surface Waters.

The Quality of Surface Waters in the United States. R. B. Dole. First of a number of reports on exhaustive analyses made to determine the quality. Gives the methods of analysis and the results. Of value to railroad engineers and industrial plants. 25000 w. U S Geol Surv—Paper 236. (1909). No. 13068 N.

Tunnel Intakes.

A Novel Method of Placing Cast Iron Wells in a Water Works Crib. Illustrates and describes methods adopted in the permanent crib in Lake Michigan, for the Chicago water-works. 3000 w. Engng-Con—April 13, 1910. No. 13090.

Typhoid.

A Classification and Study of the Typhoid Statistics of the Cities of the United States. George Rodney Taylor. Statistics of interest in connection with pure water supply. 4000 w. Eng News—April 21, 1910. No. 13254.

Water Towers.

Two Water Towers at Leiden (De tweede Watertoren van de Leidsche Duinwater-Maatschappij aan den Hoogen Rijndijk te Leiden). W. C. Van Manen. Illustrated description. 2200 w. De Ingenieur—March 5, 1910. No. 13522 D.

Water Works.

The Matzendorf Water Works of the Vienna Water-Supply System (Das Wasserwerk der Stadt Wien in Matzendorf). Alexander Swetz. Describes a plant for the development of a ground-water supply. Ills. 8000 w. Zeitschr d Oest Ing u Arch Ver—March 18, 1910. No. 13398 D.

The Coulouvrenière Plant and the Water-Works System of Geneva and Vicinity (Notice sur l'Usine de la Coulouvrenière et le Service des Eaux de la Ville de Genève et des Environs). M. Vagneux. Describes a system supplying water at low pressure for domestic purposes, and at high pressure for motive power. 2500 w. Ann d Ponts et Chaussées—1910-I. No. 13310 E + F.

Wells.

Lowering Water Level in Wells of Frankfort, Ind. J. B. Marvin. An account of the trouble, and of a growth of algae believed to be due to the use of compressed air. 1000 w. Munic Engng—April, 1910. No. 13226 C.

The Artesian Wells of the Water Supply of Memphis, Tenn. An account of an unusual system of supply. 1500 w. Munic Engng—April, 1910. No. 13225 C.

See also Pollution, under WATER SUPPLY.

WATERWAYS AND HARBORS.

Barge Canal.

The Construction of the New York State Barge Canal. Data from the annual report of Frank M. Williams showing the present condition of this great engineering work, with illustrated descriptions of recent work on various contracts. 12500 w. Eng Rec—April 2, 1910. No. 12841.

Cofferdams.

A Portable Floating Cofferdam. Illustrates and describes details of a cofferdam used on the Minidoka project of the U. S. Reclamation Service on the Snake River in Southern Idaho, for setting a number of large, heavy penstock gates and trash racks. 1500 w. Eng Rec—April 2, 1910. No. 12842.

Cumberland River.

Cumberland River Canalization. William W. Harts. Recent work on the canalized portion of the river is illustrated and described and cost records given. 1000 w. Eng Rec—April 16, 1910. No. 13133.

Detroit River.

Progress in the Improvement of the Detroit River. Excavation work to provide a minimum depth of 22 ft. is illustrated and described. 3000 w. Eng Rec—April 2, 1910. No. 12830.

Docks.

The New Dock Facilities at Avonmouth, England. Map, plan, and sections, with description of recent improvements carried out at Avonmouth, on the Bristol Channel. 2500 w. Eng News—April 28, 1910. No. 13571.

The New King's Dock at Swansea. C. van Langendonck. Illustrated description of this great dock and its construction. 2000 w. Sci Am Sup—April 2, 1910. No. 12786.

Dover, Eng.

The Port of Dover. Arthur T. Walmisley. Reviews the history of this port. Map. Discussion. 9800 w. Jour Soc of Arts—April 15, 1910. No. 13439 A.

Dry Docks.

The New Dry-Dock of the Toledo Shipbuilding Company. Harry C. McClure. Illustrated description of a concrete dock on the Maumee River, at Toledo, Ohio. 2200 w. Eng Rec—April 2, 1910. No. 12856.

Extension of the Castigneau Dry Dock at the Toulon Arsenal (Note sur les Travaux d'Allongement du Bassin de Castigneau à l'Arsenal de Toulon). M. Maroger. Describes the work of adding 25 metres to the length of the dock. Ills. 7500 w. Ann d Ponts et Chaussées—1910-I. No. 13307 E + F.

Floods.

Floods in the River Seine. Thomas P. Roberts. Remarks on proposed means to mitigate flood conditions at Paris. Discussion. 6000 w. Pro Engrs' Soc of W Penn—March, 1910. No. 13074 D.

The Effects of the Seine Floods in Paris and Vicinity (Les Effets de la Crue de la Seine du 28 Janvier 1910 dans Paris et sa Banlieue). A. Dumas. Illustrated discussion of temporary and permanent effects. 7500 w. Génie Civil—March 26, 1910. No. 13340 D.

Lighthouses.

Unattended Fog Signal and Lighthouse at Guernsey. The lighthouse situated on the isolated rock known as the Platte Fougère, at the entrance to the Little Russel Channel, is illustrated and described, especially the powerful fog signal. 1800 w. Engr, Lond—April 8, 1910. No. 13173 A.

Locks.

Building the Huge Concrete Locks at Gatun, Panama. Illustrated description of special appliances by which locks 400 ft. wide, 4000 ft. long and 90 to 100 ft. deep are constructed. 1600 w. Sci Am—April 2, 1910. No. 12785.

Methods and Cost of Constructing a Concrete Lock on the Illinois and Mississippi Canal. Data relating to the construction of what is known as the Feeder Guard Lock. Ills. 4500 w. Engng-Con—April 27, 1910. No. 13555.

Lock of the Black Rock Harbor Improvement, Buffalo. Government work in the Niagara River is illustrated and described, including a ship lock 122 x 817 ft. in plan. 2500 w. Eng Rec—April 2, 1910. No. 12833.

See also Canal Haulage, under STREET AND ELECTRIC RAILWAYS.

Panama Canal.

The Magnitude of the Operations at Panama. Gives four plates and general information of the methods and equipment for carrying on this great work. 1800 w. Eng Rec—April 23, 1910. No. 13424.

See also Excavation, under CONSTRUCTION; and Locks, under WATERWAYS AND HARBORS.

Pollution.

A Notable British Court Decision Regarding Stream Pollution by the Birmingham Sewage Works. The court employed its own expert to submit evidence, and decided that the effluent discharged was better than the stream that received it. 4000 w. Eng News—April 21, 1910. No. 13260.

Rock Removal.

Rock-Drill Vessel for the Austrian Marine Department at Triest (Felsenbohrschiff für die k. k. Seebehörde in Triest). Carl Stromek. Describes the equipment of a vessel for rock excavation in Triest harbor. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—March 26, 1910. No. 13514 D.

Seepage Losses.

A Study of Seepage Losses from Streams in Owens Valley, California. Charles H. Lee. Describes Owens Valley, and reports the method of study and the conclusions. Ills. 2500 w. Eng News—April 21, 1910. No. 13253.

Shore Protection.

Revetments Along the Rio Grande. George A. McKay. Remarks on river bank protection, with a description of the scheme used by the Mexican Government along the Rio Grande. 1800 w. Harvard Engng Jour—April, 1910. No. 13550 D.

Soil Erosion.

The Influence of Sand of One Size on the Quantity of Sand of Another Size That a Stream Will Transport. E. C. Murphy. Gives interesting data obtained in a study made by the writer. 900 w. Cornell Civ Engr—April, 1910. No. 13545 C.

Tractive, Propulsive and Erosive Power of River Currents (Einige Untersuchungen über die Schlepp-, Stoss- oder Räumungskraft in Flüssen). Wilhelm Plenkner. A review of investigations. Serial. 1st part. 5000 w. Oest Wochenschr f d Oeffent Baudienst—March 5, 1910. No. 13501 D.

Reproduction in Models of the Phenomena of the Movement of Sands in Rivers and Along the Coast (Riproduzione su Modelli dei Fenomeni di Sabbie mobili nei Fiumi e lungo i Litorali). Mario Majocchi. A review of investigations. Ills. 5000 w. Monit Tech—March 10, 1910. No. 13350 D.

Stream Gauging.

See same title, under MEASUREMENT.

Transfer Bridges.

Oak Point Float Bridge Substructure Construction. Illustrated description of the substructure for the 12 transfer bridges in the improved freight yard of the N. Y., N. H. & H. R. R. in the Bronx, New York. 2500 w. Eng Rec—April 2, 1910. No. 12837.

Water Powers.

Water Power on Our Northern Slope to James Bay, Province of Ontario. L. V. Rorke. Abridged from an address before the Engrs' Club, Toronto. Information in regard to the great amount of water power available. 2200 w. Can Engr—April 15, 1910. No. 13126.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Weir Formulae.

Experiments Upon the Flow of Water Over Triangular Notches. James Barr. An illustrated account of investigations for verifying the formula proposed by Mr. James Thomson. 3000 w. Engng—April 8, 1910. Serial. 1st part. No. 13164 A.

MISCELLANY.

Building Vibrations.

Displacements of the Top of the Eiffel Tower (Les Déplacements quotidiens du Sommet de la Tour Eiffel). E. Bret. Discusses the displacements, amounting in some cases to 24 centimetres, caused by the action of sun and wind. Ills. 3500 w. Génie Civil—March 12, 1910. No. 13337 D.

Construction Camps.

Sanitation in Construction Camps of the Catskill Aqueduct. Plans and illustrated description of measures taken for the careful protection of the watersheds from pollution. 3000 w. Eng Rec—April 2, 1910. No. 12844.

Forestry.

The Influence of Forests on Climate, Floods and Erosion. George F. Swain. Extracts from a discussion of a report by Prof. Willis L. Moore, taken from an advance copy of a contribution to *American Forestry.* 6000 w. Eng News—April 14, 1910. No. 13102.

Indian State Forestry. Saint-Hill Eardley-Wilmot. Information concerning state forestry in India and the chief factors of its success. Discussion. 12500 w. Jour Soc of Arts—April 1, 1910. No. 13032 A.

Peru.

Some Conditions, Methods and Costs of Construction Work, in Peru, South America. Ills. 1800 w. Engng-Con—April 27, 1910. No. 13558.

Wood Refuse.

Alcohol from Wood Waste. Prof. R. F. Ruttan. Read before the Soc. of Chem. Ind. An explanation of its chemistry and processes. 4500 w. Sci Am Sup—April 16, 1910. No. 13111.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy (Telegrafia senza Fili). G. Marconi. An address delivered on the occasion of the presentation of the Nobel prize. Ills. Serial. 1st part. 1800 w. Industria—March 13, 1910. No. 13348 D.

The Employment of the Stone Intermediate Circuit in Radiotelegraphy and Radiotelephony (Sur l'Emploi du Circuit intermédiaire de Stone en Radiotélégraphie et en Radiotéléphonie). M. Bethenod. Mathematical discussion of the use of intermediate circuits. Ills. 5500 w. Bul Soc Int des Elecns—March, 1910. No. 13312 F.

The Boulogne-sur-Mer Radiotelegraphic Station (Le Poste de Télégraphie sans Fil de Boulogne-sur-Mer). J. A. Montpellier. Description of the Bellini-Tosi system and the Boulogne-sur-Mer station. Ills. 2700 w. L'Elecn—March 19, 1910. No. 13326 D.

Results Obtained at the Radiotelegraphic Station at Boulogne-sur-Mer (Résultats obtenus an Poste radiotélégraphique de Boulogne-sur-Mer). M. Tosi. Results of trials of the Bellini-Tosi system. Ills. 4000 w. Bul Soc Int des Elecns—March, 1910. No. 13313 F.

Radiotelephony.

See Radiotelegraphy, under COMMUNICATION.

Telegraphy.

The Kitsée Cable Relay. Illustrated description of the Kitsée cable telegraph system which permits signals being received by a common sounder. 1200 w. Elec Rev, N Y—April 30, 1910. No. 13622.

Telephony.

Future Telephone Service by Meter. Francis Dagger. Illustrated description of the system of the Telechromometer Co., of Rochester, N. Y. 1200 w. Can Elec News—April, 1910. No. 12857 C.

The Adaptation of the Test Wire to Telephony. Dr. W. Lulofs. Describes an arrangement whereby the test wires on an electrical distribution system can be used simultaneously for telephonic and pressure test purposes. 1500 w. Elect'n, Lond—April 1, 1910. No. 13043 A.

Telharmonium.

Electrical Transmission of Music. Illustrated account of recent developments in the Cahill Telharmonic system. 3500 w. Elec Wld—April 28, 1910. No. 13560.

Submarine Cables.

The Gott-Raymond-Barker Calibrated Curve-Sheet for Jona Graphs. Edward Raymond-Barker. Note for submarine cable staffs in regard to the application of graphic methods to the electrical localization of cable breaks. 1000 w. Elec Rev, Lond—April 8, 1910. No. 13156 A.

DISTRIBUTION.

Fuses.

Some Experience in Fuse Design and Operation. James A. Seager. An account of experiences showing difficulties encountered. 1500 w. Elec Rev, N Y—April 30, 1910. No. 13620.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Automatic Regulation of Alternators. M. Seidner. Abstract of an article in the *Elek. Zeit.* Discusses the possibilities of regulation, and describes types of regulators. 2200 w. Elect'n, Lond—April 5, 1910. Serial. 1st part. No. 13458 A.

Recent Arrangements for the Parallel Operation of Electrical Machinery (Neuere Einrichtungen für den Parallelbetrieb elektrischer Maschinen). Herr Wolf. Describes a number of methods developed by German firms. Ills. 3000 w. Elektrotech u Maschinenbau—March 20 1910. No. 13518 D.

A. C. Motors.

Single-Phase and Polyphase Commutator Motors (Etude des Moteurs alternatifs monophasés et polyphasés à Collecteur). Eugène Perdu. A detailed study of their design, operation, and applications. Ills. Serial. 1st part. 4500 w. Tech Mod—March, 1910. No. 13324 D.

A. C. Turbo-Generators.

Turbo-Alternator Design. H. G. Reist. Illustrated discussion of problems peculiar to this type, because of the high speeds involved. 2200 w. Sib Jour of Engng—April, 1910. No. 13542 C.

D. C. Motors.

Compound Motors. L. Crouch. Considers the differences between the two types as regards characteristics and design, and compares with other types. 1500 w. Prac Engr—April 1, 1910. Serial. 1st part. No. 13047 A.

A 2000 Horsepower Direct Current Motor. J. B. Van Brussel. Illustrates and describes one of the largest d. c. motors yet constructed, with an elaborate system of rheostat control. 1200 w. Power—April 26, 1910. No. 13477.

Depreciation.

See same title, under INDUSTRIAL ECONOMY.

Induction Motors.

The Relation Between the Stator and Rotor Circuits of the Single-Phase Induction Motor. C. F. Smith. Discusses the connection between the current and voltage in the stator and in the rotor, and deduces expressions for use in calculations. 3500 w. Elect'n, Lond—March 25, 1910. No. 12924 A.

Phase Advances.

Westinghouse Phase Advancer. Illustrated description of the invention of Miles Walker, with statement of advantages claimed. 3000 w. Elec Engr, Lond—April 8, 1910. No. 13151 A.

Repulsion Motors.

The Theory and Design of Repulsion Motors (Theorie und Berechnung des Repulsionsmotors). F. Rusch. Mathematical. Ills. Serial. 1st part. 2000 w. Elektrotech u Maschinenbau—March 6, 1910. No. 13517 D.

ELECTRO-CHEMISTRY.

Bleaching.

Electrolytic Bleaching. Ernest Reuss. Describes the use of electricity to produce bleaching liquor from salt water. Ills. 1500 w. Elec Rev, Lond—April 15, 1910. No. 13457 A.

Corrosion.

Corrosion of Iron and Steel. Editorial discussion of theories advanced. 1500 w. Ry Age Gaz—April 22, 1910. No. 13406.

Concerning the Corrosion of Metals by Water. George W. Fuller. Urges a study of this subject, giving facts from experience to make clear the difficulties of the problem. 3500 w. Eng Rec—April 23, 1910. No. 13423.

Lecture on "The Corrosion of Iron and Steel." Cecil H. Desch. Briefly considers the three forms of accelerated tests employed, and discusses the question of protection. Discussion. 7500 w. Jour W of Scotland Ir & St Inst—Nov. 19, 1909. No. 13530 N.

Dyeing.

Electrical Theory of Dyeing. W. W. Haldane Gee and William Harrison. Abstract of paper read before the Faraday Soc. Brief report of experiments. 1500 w. Elec Engr, Lond—April 15, 1910. No. 13454 A.

Electric Furnaces.

Chilling or Heating Action of Furnace Electrodes Versus Least Electrode Loss. Carl Hering. Discusses the choice from the standpoint of the designer and constructor of furnaces, and analyzes the underlying principles. 3000 w. Met & Chem Engng—April, 1910. No. 12800 C.

Electroplating.

The Importance of Cleaning the Anodes in Brass Plating. Suggestions for brass plating. 1000 w. Brass Wld—April, 1910. No. 13429.

Nitrogen.

The Fixation of Atmospheric Nitrogen and the Food Supply. Leo Frank Guttman. Reviews the work in this field and its importance. 2500 w. Can Min Jour—April 15, 1910. No. 13187.

Ozone.

See Purification, under CIVIL ENGINEERING, WATER SUPPLY.

ELECTRO-PHYSICS.

Electric Waves.

Electric Waves and the Electromagnetic Theory of Light. Abstract of Sir J. J. Thomson's concluding lecture before the Royal Institution. 2500 w. Engng—March 25, 1910. No. 12936 A.

Electromagnets.

Enameled-Wire Windings. Charles R. Underhill. Gives data in regard to the space-factor of electromagnetic windings, and the heat-resisting qualities of the insulation. 1000 w. Elec Wld—April 21, 1910. No. 13252.

Torque Tests on Electromagnets (Zugkraftversuche an Elektromagneten). Alois Berninger and Robert Edler. Reports results additional to those already published. Ills. Serial. 1st part. 1500 w. Elektrotech u Machinenbau—March 27, 1910. No. 13520 D.

Induction Coils.

The Induction Coil. Benjamin F. Bailey. Explains its principles, giving oscillograph diagrams to illustrate its operation. 4000 w. Elec Wld—April 14, 1910. Serial. 1st part. No. 13097.

Magnetic Properties.

Effect of Temperature Upon the Magnetic Properties of Electrolytic Iron. E. M. Terry. Abstract of an article in the *Phys. Rev.* Describes investigations and states results. 3500 w. Elect'n, Lond—April 15, 1910. No. 13459 A.

The Magnetic Properties of Electrolytic Iron and Some Commercial Steels. Charles F. Burgess and James Aston. Gives data of tests made on samples of electrolytic iron, together with those upon the original anode material, indicating thus the effect of refining upon the magnetic quality. 1500 w. Met & Chem Engng—April, 1910. No. 12801 C.

Resistances.

A Standard Resistance with Balanced Inductance and Capacity. S. Leroy Brown. Abstract of an article in the *Phys. Rev.* Shows that a parallel wire standard of resistance can be constructed which is free from inductance when used with interrupted steady current or with alternating current of moderate frequency. 2500 w. Elect'n, Lond—April 1, 1910. No. 13045 A.

Spark Potentials.

Alternating-Current Spark Potentials and Their Relation to the Radius of the Curvature of the Electrodes. J. de Kowalski and J. Rappel. Abstract from the *Philo. Mag.* A report of determinations by the writers, and a comparison with those of other physicists. 1200 w. Elect'n. Lond—March 25, 1910. No. 12925 A.

GENERATING STATIONS.

Auxiliary Plants.

Emergency Generating Stations for Service in Connection with Hydroelectric Transmission Plants Under Pacific Coast Conditions. A. M. Hunt. Discusses the types of stations for this service, comparing a station having generators driven by gas engines, and one in which steam-driven turbo-generators are used. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13233 F.

Reserve Power Station. M. G. Kennedy. Illustrated description of the power plant and system of the Syracuse Lighting Company. 2500 w. Elec Wld—April 21, 1910. No. 13251.

Central Stations.

Some Methods of Improving Central-Station Engine Economy. William Westerfield. Suggestions for correcting wastefulness in engine operation. 2000 w. Elec Wld—April 7, 1910. No. 12996.

New Turbine Station at Cincinnati. Illustrated detailed description of the new

Pendleton generating station, which presents many noteworthy features. 3500 w. Elec Ry Jour—April 30, 1910. No. 13578.

Combined Industrial Power and Town Lighting Plant. A plant at Manchester, Ind., a town of about 3500 population, is illustrated and described. 1200 w. Elec Wld—April 7, 1910. No. 12993.

Norfolk's Traction Power Plant. Warren O. Rogers. Illustrated description of equipment in a 10000-K.W. Curtis turbine plant. The coal handling facilities by water or rail are of special interest. 2000 w. Power—April 19, 1910. No. 13179.

Dundee and Its Electricity Station. Plans and description of a municipal plant in Scotland, costing over £100,000. 5000 w. Elec Engr, Lond—April 8, 1910. No. 13150 A.

The Dundee Municipal Power Plant. Illustrated description of an installation in Scotland that has cost over £100,000. 2000 w. Elec Rev, Lond—April 1, 1910. Serial. 1st part. No. 13040 A.

The San Paolo Power Plant. C. L. Durand. Illustrated description of a turbine-driven central station for Rome, Italy. 2500 w. Elec Rev, N Y—April 16, 1910. No. 13131.

The Shamrock Steam-Turbine Power Plant of the Hibernia Mines, Herne i. W., Germany (Das Dampfturbinenkraftwerk der Zeche Shamrock I/II der Bergwerksgesellschaft "Hibernia" in Herne i. W.) Illustrated description of an important plant serving a group of mines in this district. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13386 D.

See also Gas Engines, under MECHANICAL ENGINEERING, Combustion Motors; and Turbines, under MECHANICAL ENGINEERING, Steam Engineering.

Costs.

First Cost of Plant and Cost of Generating and Distributing Electricity for Lighting, Edison Electric Illuminating Co. of Brooklyn. Details of the unit cost of producing and distributing electricity for lighting. 7000 w. Engng-Con—April 6, 1910. No. 12956.

Economics.

Economies of a Small Central Station. An account of the development of the business of the Gardner, Mass., Electric Light Company. 2500 w. Elec Wld—April 7, 1910. No. 12995.

Hydro-Electric.

Analysis of Water-Power Propositions. Edwin J. Bengler. Gives an analysis with a view to assisting in the compilation of complete engineering reports on proposed water-power developments. Also discussion. 4000 w. Jour Assn of Engng Soc's—March, 1910. No. 13527 C.

Water Power and Its Development. Charles Edward Lucke. Seventh Hewitt lecture delivered at Cooper Union. Discusses considerations to be taken into account in the selection and development of suitable sites. 2000 w. Power—April 5, 1910. No. 12911.

The Utilization of Water Powers (Die Ausnützung der Wasserkräfte). Albert Loacker. A discussion of the general principles of economical water-power development. 8500 w. Die Turbine—March 20, 1910. No. 13383 D.

A General Review of Hydroelectric-Engineering Practice. Frank Koester. This second article of a series deals with head races, pressure pipes and penstocks. Ills. 3500 w. Engineering Magazine—May, 1910. No. 13589 B.

Parallel Operation of Hydroelectric Plants. W. S. Lee. Presents some advantages to be gained by operating in parallel so as to exchange power from one plant to another. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13232 F.

Hydroelectric Energy for Farmers. Illustrated description of a low-head plant in Indiana for the supply of electricity in a rural community. 2000 w. Elec Wld—April 7, 1910. No. 12994.

A Small Water Power Plant for a Paper Mill. Plan, cross-sections and description of a plant at Lincoln, N. H. 1500 w. Eng Rec—April 16, 1910. No. 13134.

Utilizing Chattahooche River Water-Power. William H. Stone. Illustrates and describes developments in progress and proposed. 3000 w. Mfrs' Rec—April 7, 1910. No. 12965.

A Hydroelectric Development on the Weber River, Utah. Illustrated description of a development of the Utah Light & Railway Co. 4500 w. Eng Rec—April 2, 1910. No. 12849.

Development of the Ninety-nine Islands Station of the Southern Power Company. Curtis A. Mees. Illustrated detailed description of the construction work on the Broad River, near Blacksburg, S. C. 4000 w. Eng Rec—April 2, 1910. No. 12827.

Dalmatian Hydroelectric Plants. Dr. Alfred Gradenwitz. Illustrated descriptions of the Jarnge and Manojlovae stations in Austria-Hungary, on the river Kerka. 2000 w. Power—April 26, 1910. No. 13475.

The Steyrdurchbruch Electrical Plant (Das Elektrizitätswerk Steyrdurchbruch). Describes an interesting small plant in Austria. Ills. 2200 w. Elektrotech u Maschinenbau—March 13, 1910. No. 13516 D.

The Valtellina Hydro-Electric Plants and the Milan Municipal Installations (Gli Impianti idroelettrici di Valtellina e le Installazioni elettriche del Comune di Milano). A. Manfredini. An exhaustive description, discussing both the technical and economic features. Ills. Serial. 1st part. 5000 w. Monit Tech—March 10, 1910. No. 13340 D.

Isolated Plants.

Electric Lighting and Power Plant of the Coast Artillery School, Fort Monroe, Va. I. N. Lewis. Illustrated description of a very complete plant for supplying heat, power and light. 3000 w. Jour U S Art—March-April, 1910. No. 13282 D.

Electricity in a Modern Infirmary. Illustrates and describes details of the electrical and mechanical installation in the new infirmary at Oak Forest, Ill. 3000 w. Elec Rev, N Y—April 2, 1910. No. 12908.

Rates.

An Equitable Sliding Scale for Rates of Electric Power. J. B. Gordon. Develops formulæ and explains method of determining rates according to a fixed law. 1800 w. Eng News—April 7, 1910. No. 13000.

Price of Electricity. R. S. Hale. Abstract of a paper before the New England section of the Nat. Elec. Lgt. Assn. Discusses the principles on which rates are based by the Boston Edison Co. 2500 w. Elec Rev, N Y—April 23, 1910. Serial. 1st part. No. 13419.

Switch Gear.

Concrete Construction of Switch Gear Compartments in European Power Plants. Stephen Q. Hayes. Illustrates and describes examples of European construction, outlining results obtained. 3500 w. Elec Jour—April, 1910. No. 13207.

Ironclad Switch-Gear for Mines. Illustrated description of the latest design of British Westinghouse Elec. & Mfr. Co., Ltd. 1200 w. Engng—April 8, 1910. No. 13165 A.

LIGHTING.

Arc Lamps.

A Short Flame Arc Lamp. A lamp known as the Timar-Dreger lamp as described by Prof. W. Wedding in the E. T. Z. No. 2, 1910. Ills. 700 w. Elec Rev, Lond—April 8, 1910. No. 13153 A.

Automobile.

See Lighting, under MECHANICAL ENGINEERING, AUTOMOBILES.

Chemistry.

Some Chemistry of Light. Dr. W. R. Whitney. Abstract of a presidential address to the American Chemical Society. Historical review of light production from the viewpoint of the chemist. 3500 w. Elec Rev, N Y—March 26, 1910. No. 13015.

Illumination.

Theoretical Notes on Interior Lighting. W. E. Barrows. Considers systems of illumination, the intensities for various classes of interior lighting, and related subjects. 1500 w. Elec Rev, N Y—April 16, 1910. Serial. 1st part. No. 13132.

Modern Stage Illumination. Dr. A. Neuburger. Illustrates and describes modern methods, especially the Fortuny system. 1200 w. Sci Am Sup—April 16, 1910. No. 13112.

A Visual Acuity Test Object. Herbert E. Ives. Illustrated description of a composite object composed of superposed gratings, and report of results obtained. Also editorial. 2500 w. Elec Wld—April 14, 1910. No. 13095.

Incandescent Lamps.

The Effect of Regulation on Incandescent Lamps. L. L. Elden, in *Nat. Elec. Lgt. Assn. Bul.* The carbon filament lamps only are considered. 1200 w. Elec Rev, N Y—April 30, 1910. No. 13621.

Searchlights.

Searchlights: Other Means of Illumination and Telephones at Port Arthur. Information translated from the *Mitteilungen ueber Gegenstaende des Artillerie- und Geniewesens.* 2000 w. Jour U S Art—March-April, 1910. No. 13287 D.

Electrical Searchlights in Coast Defense (I Proiettori elettrici per la Difesa delle Coste). Giulio Bertolini. An exhaustive discussion of the military value of searchlights. Ills. 20000 w. Riv Marit—March, 1910. No. 13342 E + F.

Street.

Steet Illumination. Francis Jehl. A report of photometric tests of street lighting in Budapest. 2000 w. Elec Wld—April 28, 1910. No. 13561.

A Comparison of Cost and Efficiency of Methods of Street Lighting. N. R. Birge, in *Gen. Elec. Rev.* 3000 w. Munic Engng—April, 1910. No. 13224 C.

MEASUREMENT.

Electrochemical Equivalents.

Researches at the Central Electrical Laboratory on the Electrochemical Equivalent of Silver (Recherches effectuées au Laboratoire Central d'Electricité sur l'Equivalent électrochimique de l'Argent). F. Laporte and P. de la Gorce. Describes methods employed and gives results. Ills. 14000 w. Bul Soc Int des Elecns—March, 1910. No. 13314 F.

Meters.

Inexpensive Alternating Current Station Recording Watt Hour Meters. H. R. Mason. Explains how to adapt the ordinary type of service meter for use in alternating-current stations. 1800 w. Power—April 19, 1910. No. 13182.

Meter Corrections (Corrections à Appliquer aux Compteurs servant à l'Enregistrement de l'Energie électrique). A. Combemale. A mathematical discussion of the correction for the errors of the meter which vary with the load, to be applied to the Thomson d. c., two-wire meter. Ills. Serial. 1st part. 1800 w. L'Elecn—March 19, 1910. No. 13327 D.

Motor Testing.

The Determination of the Efficiency of Continuous-Current Machines. W. C. Clinton. Remarks on the methods used. Diagrams. 1000 w. Elect'n, Lond—April 15, 1910. No. 13460 A.

Rating and Testing of Motors for Intermittent Working. Dr. R. Pohl. Abstract of a paper read before the Yorkshire local section of the Inst. of Elec. Engrs. Shows that short-time tests are very misleading. Discusses the proposed tests of Goldschmidt and Broughton, and suggests a continuously running test. 3500 w. Elect'n, Lond—March 25, 1910. No. 12923 A.

Standards.

An International Co-operative Investigation on Electrical Standards. Edward B. Rosa. The latest information relating to the international standardization of concrete electrical units. Also editorial. 2500 w. Elec Wld—April 7, 1910. No. 12980.

Researches at the Central Electrical Laboratory on the Standards of Resistance and of Electromotive Force (Recherches faites au Laboratoire Central d'Electricité sur l'Etalon de Résistance et l'Etalon de Force électromotrice). R. Jouaust. Describes methods and gives results. 10000 w. Bul Soc Int des Elecns—March, 1910. No. 13315 F.

Transformer Testing.

Testing Transformers. J. W. Himmelsbach. Explains how to determine losses in transformer windings and how to keep card records of tests. 800 w. Power—April 12, 1910. No. 13028.

Units.

See Standards, under MEASUREMENT.

TRANSMISSION.

Cables.

Cost of Cable Laying. E. Capone. Information relating to the cost of recent cable laying in England, giving tables for computing costs and explaining their use. 1800 w. Tram & Ry Wld—April 7, 1910. No. 13443 B.

Conduits.

Underground Conduits. Paul B. Witham. Presents the advantage of a general plan and system in the location of conduits, pipes, etc., in city streets. Ills. 700 w. Elec Wld—April 28, 1910. No. 13564.

The Laying of Vitirified Conduit. Harry C. Spillman. Discusses considerations governing choice of route, type of conduit, and method of installation. Ills. 1500 w. Elec Wld—April 7, 1910. No. 12907.

Direct Current.

The Series System of High-Tension, Direct-Current Transmission (Transporte de Energia Electrica por Corriente continua a alto Voltaje, Sistema "Serie"). Jaime Font Mas. The first part discusses the Moutier-Lyon installation. Ills. Serial. 1st part. 3000 w. Energia Elec—March 25, 1910. No. 13353 D.

Lightning Protection.

Lightning Protection. Percy H. Thomas. Considers the effects of lightning, and the protective devices for line and station. Ills. 2000 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13236 F.

Line Design.

Transmission Line Calculations. John F. H. Douglas. Gives a short method for determining the regulation. 800 w. Elec Wld—April 28, 1910. No. 13563.

The Study of an Electricity Distribution Project (Noté sur l'Etude d'un Projet de Distribution d'Energie électrique). F. Scoumanne. A detailed demonstration of various methods of calculating distribution networks. Ills. 9000 w. Soc Belge d'Elecns—March, 1910. No. 13303 E.

Lines.

The Developed High Tension Net-Work of a General Power System. Paul M. Downing. Confined to conditions in California at the present time. Ills. 4500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13234 F.

Poles.

Steel Structures for High-Tension Transmission Lines and Special Crossings. W. K. Archbold. Illustrates and describes types of structures discussing their design and construction. 1500 w. Elec Jour—April, 1910. No. 13206.

Regulations.

The German and Vienese Safety Regulations for Overhead Wires (Ueber die Deutschen und Wiener Sicherheitsvorschriften für Freileitungen). A. Kohler. A comparison of the rules of the German Association of Electrical Engineers and the Vienna Electrical Society. Ills. 4000 w. Elektrotech u Maschinenbau—March 27, 1910. No. 13519 D.

Substations.

An Arc Lighting Substation. M. Stoppoloni. Illustrated description of a motor-generator substation in Milan, Italy. 2000 w. Elec Wld—April 28, 1910. No. 13559.

Transformers.

The Drying of High-Tension Transformers and Transformer Oil. R. W. Krass. Discusses methods of effecting the separation of oil and water when moisture is present in small quantities. Ills. 1500 w. Sib Jour of Engng—April, 1910. No. 13540 C.

Ratings of Single-Phase Transformers for Grouping on Polyphase Circuits. H. C. Soule. Analyzes the various groupings, explaining why certain groupings should have transformers of larger rated kilovolt-ampere capacity than indicated. 1200 w. Elec Jour—April, 1910. No. 13209.

Operation of Delta and V-Connected Transformers in Parallel. E. C. Stone. Considers transformer capacities available with various combinations of V and delta groups of units. 1000 w. Elec Jour—April, 1910. No. 13210.

Reactance of Shell Type Transformers. G. Faccioli. Explains a method for determining the local magnetic leakage reactance. 2000 w. Elec Wld—April 14, 1910. No. 13006.

MISCELLANY.

Aluminium.

Resistivity and Thermo-Electric Properties of Aluminium and Copper-Aluminium Alloys (Resistivité et Thermo-Electricité des Aluminiums et des Cupro-Aluminiums). H. Pécheux. Reports results of researches on the influence of impurities and of copper on the electrical properties of aluminium. Ills. 3000 w. Rev Gen des Sci—March 30, 1910. No. 13320 D.

Insulating Materials.

Impregnation of Coils with Solid Compounds. J. R. Sanborn. Illustrates and describes the process and apparatus used in impregnating coils, the materials for the compound, methods of testing, etc. 3500 w. Elec Jour—March, 1910. No. 12313.

Insulating Oils (Note sur les Huiles d'Isolement). A brief review of an exhaustive report on the subject recently presented to the Sociéte Belge d'Electriciens. Ills. 3000 w. Soc Belge d'Elecns —Feb., 1910. No. 12620 E.

The Physical Properties of Switch and Transformer Oils. W. Pollard Digby and D. B. Mellis. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes investigations of some of the physical and chemical changes in oils, due to their use in transformers and switches. 5000 w. Elect'n, Lond—April 1, 1910. No. 13041 A.

INDUSTRIAL ECONOMY.

Apprenticeship.

A Successful Apprenticeship System in a Large Plant. Charles H. Logue. Brief account of training methods at the East Pittsburg Works of the Westinghouse Co. Ills. 1800 w. Am Mach—Vol. 33. No. 16. No. 13247.

Apprenticeship System of the Fore River Shipbuilding Co. J. E. Neary. An explanation of a system that has given satisfactory results. Ills. 1200 w. Am Mach—Vol. 33. No. 17. No. 13553.

Industrial Apprenticeship and Obligatory Professional Instruction (L'Apprentissage industriel et l'Enseignement professionnel obligatoire). P. Astier. A discussion of conditions in France and means of improving them. 4500 w. Tech Mod—March, 1910. No. 13323 D.

See also Education, under INDUSTRIAL ECONOMY.

British Trade.

Foreign Competition: Its Growth and Effects. W. O. Horsnaill. A discussion of the British engineering industry and its future outlook. 3000 w. Elec Rev, Lond—April 8, 1910. No. 13154 A.

Canada.

Engineering in Canada. Walter J. Francis. Reviews what has been accomplished and considers the future of engineering in Canada. 3000 w. Ap Sci—March, 1910. No. 13214 C.

Depreciation.

Depreciation. Major W. A. J. O'Meara. Abstract of paper read before the Inst. of P. O. Elec. Engrs. Discusses physical decay, obsolescence, inadequacy, tenure of holding, etc., and the life of machinery and other plant. 4500 w. Elect'n, Lond—April 8, 1910. No. 13157 A.

The Depreciation and Maintenance of Electrical Equipment. George W. Cravens. Considering the different methods of accounting in use, advocating the sliding scale method. 3500 w. Elec Rev, N Y—April 23, 1910. No. 13420.

Education.

Industrial Education. K. A. Mackenzie. Discussion of the needs in this line in Canada. 2500 w. Ap Sci—March, 1910. No. 13219 C.

The Movement Toward a National System of Technical Education. Dr. R. Pohl. Abstract of a paper read before the Assn. of Teachers in Tech. Inst. 2200 w. Elect'n, Lond—April 15, 1910. No. 13461 A.

Criticism of the Engineering Schools. Dugald C. Jackson. A lecture before Stevens Engng. Soc. 4000 w. Stevens Ind—March, 1910. No. 13499 D.

Education for Leadership in Electrical Engineering. Samuel Sheldon. Aims to give the characteristics of such leaders, considering what education can do toward developing the essentials, and discussing problems related. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13228 F.

The Apprenticeship Course and the Engineering Graduate. Charles F. Scott. Explains how experience and opportunity may be secured in the apprenticeship course of an electric manufacturing company. 3000 w. Elec Jour—April, 1910. No. 13208.

The Mining Department of the University of Leeds. Illustrates and describes the work in mining and metallurgy. 1500 w. Col Guard—March 24, 1910. Serial. 1st part. No. 12933 A.

The Reform of Technical Education in France and the Reorganization of Apprenticeship (La Réforme de l'Enseignement technique en France et la Reorganisation de l'Apprentissage). G. Zeigler. A general discussion of problems pressing for solution. 3300 w. Rev d'Econ Indus—March 20, 1910. No. 13300 D.

Employers' Liability.

Employers' Liability Insurance. Miles M. Dawson. From an address before the Nat. Metal Trades Assn. Discusses how employers' associations of the United States may improve on present methods. 2500 w. Ir Age—April 21, 1910. No. 13278.

Engineering.

Presidential Address of James Charles Inglis. Discusses the professional standing of the civil engineer and the position he occupies in relation to certain economic questions. 5800 w. Inst of Civ Engrs—Nov. 2, 1909. No. 13277 N.

Engineering Ethics.

Principles of Professional Practice. A circular letter issued by the American Institute of Architects offering advice concerning the principles that should govern conduct. 1700 w. Eng Rec—April 16, 1910. No. 13139.

Exhibitions.

The Brussels International Exhibitions. Information concerning the exhibition to be opened April 23, 1910. Plans. 2000 w. Engng—April 1, 1910. No. 13055 A.

Labor Insurance.

Unemployment Insurance. Discusses in detail the Bill for the Insurance of Workmen Against Unemployment, which it is expected will soon be introduced in England. 2000 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13172 A.

See also Employers' Liability, under INDUSTRIAL ECONOMY.

Management.

Modern Methods of Shop Management. Frederick A. Waldron. Gives details of a system taken from actual practice. 5000 w. Ir Age—April 28, 1910. No. 13566.

Saving Waste in Manufacturing—A Field of Work in Which the Technical Graduate Might Well Look for a Future. J. C. Armer. 1800 w. Ap Sci—March, 1910. No. 13216 C.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. An explanation of simple and reliable methods of foundry management and accounting. 3300 w. Engineering Magazine—May, 1910. No. 13592 B.

See also same title, under RAILWAY ENGINEERING, MISCELLANY.

Patents.

How to Keep an English Patent Alive. Gives the most convenient methods by which a person foreign to England may comply with the law. 1200 w. Eng News—April 21, 1910. No. 13256.

Patent Legislation (Octrooiwetgeving). G. H. E. Bergsma. A discussion of the patent situation in the Netherlands. Ills. 21000 w. De Ingenieur—March 26, 1910. No. 13525 D.

Strikes.

Phases of the Philadelphia Strike. Daniel T. Pierce. Information as to phases of the strike on the system of the Philadelphia Rapid Transit Co. 2200 w. Elec Ry Jour—April 23, 1910. No. 13298.

Trusts.

The Operation of Kartels (Fonctionnement de quelques Kartels). Notes from a recent book by M. Huré on the development and operation of the German kartel system. Serial. 1st part. 2500 w. Rev d'Econ Indus—March 20, 1910. No. 13302 D.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. This fourth article of a series gives colored charts showing graphically the results, and comments making clear the benefits of the bonus system in fixing habits of industry. 6000 w. Engineering Magazine—May, 1910. No. 13588 B.

MARINE AND NAVAL ENGINEERING.

Barges.

The "Viking"—Self-Dumping Deck Scow. Illustrated description of a novel system devised by A. F. Viking. 1200 w. Sci Am—April 16, 1910. No. 13100.

Battleships.

H. M. S. Colossus. Illustrated description of a recently launched battleship. 700 w. Engr, Lond—April 15, 1910. No. 13467 A.

The Japanese Battleship Satsuma. Illustration, with brief description. 1000 w. Engr, Lond—April 15, 1910. No. 13470 A.

The Projected French 23,400-Ton Battleships. Illustration and information concerning the projected French battleships and their armament. 1000 w. Engr, Lond—April 8, 1910. No. 13174 A.

The Disposition of Guns on Battleships (Sulla Disposizione delle Artiglierie a Bordo delle grandi Navi da Battaglia). A discussion of the disposition of armament on the latest British battleships. Ills. 2500 w. Riv Marit—March, 1910. No. 13343 E + F.

British Navy.

Twenty-one Years of British Warship Building. Archibald S. Hurd. The development of the British fleet, and the activity in warship building and allied industries. 3500 w. Cassier's Mag—April, 1910. No. 13188 B.

Electric Power.

The Electric Motor for Marine Propulsion. William P. Durtnall. Read before the Inst. of Nav. Archts. Considers the possibilities of electrical power generation and transmission and means of regulating propeller speed in steam vessels. 8000 w. Elec Engr, Lond—March 25, 1910. Serial. 1st part. No. 12922 A.

Marine Propulsion by Electric Motors. Henry Alexander Mavor. Discusses the problem of economical power production, describing a change-speed gear for large steamers. Discussion. Ills. 21500 w. Inst of Civ Engrs, No. 3822—Dec. 7, 1909. No. 13272 N.

Improved Apparatus for Warping, Winding, Hoisting, Etc., on Board Ships. Jas. A. Liddle. Read before the Inst. of Marine Engrs. States the requirements of electrical machinery on board ship, and discusses details. 2500 w. Mech Wld—April 1, 1910. Serial. 1st part. No. 13054 A.

Ferry Steamers.

Some Notes on the Erection of the Baikal Railway Ferry Steamers. Isaac O. Hondy. Illustrated description of the ice breaking train ferry steamers and their construction. 2500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13413 N.

Grain Elevators.

The Mitchell Cantilever Grain Elevator. August F. Bock. Illustrated description of an interesting English floating elevator. 1200 w. Ir Age—April 7, 1910. No. 12947.

Gunboats.

Gunboat for Macao. Illustrated description of a shallow-draught gunboat built for the Portuguese Government. 1000 w. Engng—April 15, 1910. No. 13462 A.

Internal-Combustion Engines.

Internal-Combustion Marine Engines. Linton Hope. Deals with the application of the internal-combustion engine to fishing and commercial vessels. Ills. 5000 w. Engng—April 1, 1910. No. 13058 A.

Action and Design of Four Cycle Marine Gas Engines. Albert H. Ziegler. Illustrates and describes various forms of combustion chambers, valves, piston heads, etc. 3500 w. Am Mach—Vol. 33. No. 15. No. 13084.

Lifeboats.

Motor Lifeboats. J. R. Barnett. Read before the Inst. of Naval Archts. Illustrates and describes the motor lifeboats of the Royal National Lifeboat Institution. 3000 w. Engng—April 1, 1910. No. 13057 A.

Motor Boats.

The International Motor Boat and Motor Exhibition (Internationale Motorboot- und Motorenausstellung). Illustrated description of the exhibits at the Berlin show. 6000 w. Motorwagen—March 31, 1910. No. 13393 D.

The Motor Boat and Motor Exhibition at Berlin, 1910 (Internationale Motorboot- und Motoren-Ausstellung Berlin, 1910). Describes the exhibits and discusses the tendencies they indicate. Serial. 1st part. 2000 w. Zeitschr d Mit Motorwagen Ver—March 31, 1910. No. 13390 D.

Motor Boats (Motorbootwesen). Ernst Andreas. A general and comprehensive discussion of their design and construction. Ills. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—March 15, 1910. No. 13388 D.

The Design of High-Speed Motor Boats (Gesichtspunkte für die Konstruktion schnellaufender Motorboote). W. Kiwull. Mathematical discussion of the design of the hull and power plant. Ills. Serial. 1st part. 5000 w. Zeitschr d Mit Motorwagen Ver—March 15, 1910. No. 13389 D.

Modern High-Speed Motor Boats (Einiges über moderne Motorenboote). Conrad Harmsen. Mathematical discussion of their design. Ills. Serial. 1st part. 3500 w. Motorwagen—March 20, 1910. No. 13392 D.

Modern Motor Boats. George H. Cutbush. Reviews present practice showing how internal-combustion engines are altering conditions and giving efficient service. 2500 w. Int Marine Engng—April, 1910. No. 12818 C.

A Small Off-Shore Cruiser. Stephen P. M. Tasker. Illustrated description of a motorboat of 31-foot length. 1200 w. Int Marine Engng—April, 1910. No. 12815 C.

See also Internal Combustion Engines, and Lifeboats, under MARINE AND NAVAL ENGINEERING.

Naval Efficiency.

The Essentials of Naval Efficiency in an Engineering Age. A lecture by Rear Admiral George W. Melville, before the Stevens Engng. Soc. Considers the changes in the material side of the question and the essentials for its efficiency, and also the requirements in the personnel. 4500 w. Stevens Ind—Jan., 1910. No. 13497 D.

Oil Fuel.

See Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Porhydrometer.

The Weight of Cargoes. A. Murray. Read before the Inst. of Nav. Archts. Describes a new method of ascertaining the weight of cargoes on board ship, by the use of the "Porhydrometer," invented by Emilio de Lorenzi, of Genoa. Ills. 1200 w. Engng—April 8, 1910. No. 13167 A.

Propellers.

Some Considerations Regarding the Phenomena of Propulsion. J. B. Henderson. Read before the Inst. of Nav. Archts. An analysis of the phenomena of propulsion, examining the jet propeller, and screw-propulsion. 5000 w. Engng—March 25, 1910. No. 12939 A.

Model Screw-Propeller Results: A Comparison. T. B. Abell. Read before the Inst. of Nav. Archts. Compares results of experiments made by D. W. Taylor, with results obtained by R. E. Froude to see how far they agree. Also notices some features brought out by their analysis. Diagrams. 3500 w. Engng—April 15, 1910. No. 13466 A.

Experimental Investigations on Wake and Thrust Deduction Valves. W. J. Luke. Read before the Inst. of Nav. Archts. Gives results of recent experiments on wake and thrust deduction, made with twin and single screws. Also editorial. 6000 w. Engng—March 25, 1910. No. 12938 A.

The Erosion of Bronze Propellers. Illustrated account of serious erosion believed to be one effect of the high speed turbine. 700 w. Sci Am—April 23, 1910. No. 13267.

Shaft Horse Power.

The Measurement of Shaft Horse-Power. B. Hopkinson. Read before Inst. of Naval Archts. Notes on the measurement of shaft horse-power, discussing the relation between twist and torque. 2500 w. Engng—April 1, 1910. No. 13059 A.

Ship Resistance.

Ship-Resistance: A Numerical Analysis of the Distribution of Effective Horse-Power. T. H. Havelock. Read before the Ap. Sci. Sec. of the Phil. Soc. of the Univ. of Durham. An outline is given of the general theory of ship-resistance, and a study of the distribution at different speeds. 2200 w. Engng—April 8, 1910. No. 13168 A.

Researches on the Resistance of Boats to Traction (Recherches sur la Resistance à la Traction des Bateaux). M. Clerc. A discussion of the measurement of speed by a recording hydrokinemometer based on the principle of the Pitot tube. Ills. 3500 w. Ann d Ponts et Chaussées—1910-I. No. 13308 E + F.

Ship Speed.

Speed and Its Attainments in Different Types of Ships. Herbert C. Sadler. Discusses speed in relation to size, and speed in relation to type or form of vessel. 3000 w. Stevens Ind—Jan., 1910. No. 13498 D.

Steamboats.

The New River Steamers City of Philadelphia and City of Wilmington. Illustrated description of new vessels for service between Philadelphia, Pa., and Wilmington, Del. 2000 w. Int Marine Engng—April, 1910. No. 12813 C.

Steam Boilers.

Notes on Marine Boiler Design, Construction and Economy. D. Myles. Calls attention to recent modifications and improvements. General discussion. 2 plates. 10000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13412 N.

Resumed Discussion on Mr. D. Myles's Paper on "Notes on Marine Boiler Design, Construction and Economy." 6500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—April, 1910. No. 13536 N.

The Boiler and Engine Equipment of the German Naval Vessel "Drache" (Die Kessel- und Maschinenanlage des deutschen Artillerietenders "Drache"). Herr Laudahn. Illustrated detailed description of a vessel for high-speed service, equipped with the Schmidt superheater. Serial. 1st part. 4500 w. Schiffbau—March 9, 1910. No. 13379 D.

Steam Engines.

See Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Steamships.

The South African Mail Steamer "Balmoral Castle." Illustrated detailed description of this fine merchant vessel. Plates. 2500 w. Engng—April 8, 1910. Serial. 1st part. No. 13166 A.

Steam Turbines.

A New Method of Reversing Turbines. Illustrates and describes Foettinger's turbine propulsion system with turbo-transformers. 3300 w. Sci Am Sup—April 2, 1910. No. 12787.

Mechanical Gearing for Marine Turbines. C. A. Parsons. Read before the Inst. of Nav. Archts. Considers the application of the marine steam-turbine and mechanical gearing to merchant ships. Ills. 2000 w. Engng—March 25, 1910. No. 12934 A.

The Föttinger Hydraulic Gear. Dr. Alfred Gradenwitz. Illustrated description of this hydraulic reduction and reversing gear for turbines, giving theory of the action and the results obtained at the Vulcan shipyards in Germany. 3500 w. Power—April 12, 1910. No. 13020.

Mr. Y. Wadajaki's Reply to the Discussion on his Paper on "The Adaptation of Steam Turbines for Propulsion of Vessels at Moderate Speeds." 2200 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13411 N.

Steam Turbines in the French Navy (Die Anwendung von Dampfturbinen fur den Antrieb von Kriegsschiffen der französischen Marine). E. Clergeau. Describes the turbine-propelled vessels and their equipment. Ills. Serial. 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13385 D.

Submarines.

The Stability of Submarines. Bernard C. Laws. An illustrated discussion of problems of equilibrium when submerged. 3000 w. Cassier's Mag—April, 1910. No. 13190 B.

Characteristics of Submarines (Rohentwurf eines Unterseebootes). K. Dietze. Gives average dimensions and characteristics of submarines deduced from existing types. 2800 w. Schiffbau—March 9, 1910. No. 13380 D.

Survey Vessels.

The Most Curious Craft Afloat. L. A. Bauer. An illustrated account of the work of the non-magnetic yacht "Carnegie," explaining the use of the compass in navigation, and giving principal facts regarding the vessel and its equipment. 5500 w. Nat Geog Mag—March, 1910. No. 13071 C.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Abbott-Detroit.

Pertinent Features of Abbott-Detroit Car. Illustrated description of the general characteristics. 2000 w. Automobile—April 28, 1910. No. 13582.

Cadillac.

The 20-30 h.p. Cadillac. Illustrated detailed description. 1200 w. Autocar—April 2, 1910. No. 13038 A.

Carbureters.

The Carbureter. Its Adjustment, and the Novice. Herbert L. Towle. Illustrates and describes various types and their working. 1500 w. Automobile—March 31, 1910. Serial. 1st part. No. 12805.

Cino.

Cino. Brief illustrated description of a touring car built in Cincinnati, Ohio. 500 w. Automobile—April 7, 1910. No. 13013.

Commercial Vehicles.

Lansden Storage Battery Trucks. Illustrated description of trucks using the Edison storage battery. 800 w. Ir Age—April 7, 1910. No. 12944.

De Dion.

The 14 h.p. De Dion-Bouton. Brief illustrated description of this model and the automatic carbureter adopted. 2000 w. Autocar—March 26, 1910. No. 12920 A.

Dennis.

The 20 h.p. Four Cylinder Four-Speed Dennis Car. Illustrates and describes the Dennis chassis, embodying the Dennis worm-drive. 700 w. Autocar—April 9, 1910. No. 13149 A.

Garages.

Commercial Vehicle Garage Management. Harold H. Brown. Gives details of the system adopted by the Autocar Co. in the conduct of its motor wagon garage in New York. 2500 w. Com Veh—April, 1910. No. 12948 C.

Ignition.

Ignition Troubles, Their Causes and Prevention (Zundaussetzer, ihre Ursachen und Beseitigung). Konradin Stauffer. A practical discussion. Ills. 4500 w. Zeitschr d Mit Motorwagen Ver—March 31, 1910. No. 13391 D.

Industry.

Our Marvelous Automobile Industry. Information and illustrations showing the rapid development, and business methods. 2000 w. Sci Am—April 9, 1910. No. 12982.

Lighting.

Electric Lighting for Motor Cars. An illustrated series of articles describing systems and mechanisms employed. 1700 w. Prac Engr—March 25, 1910. Serial. 1st part. No. 13158 A.

Electric Light for Cars. An illustrated discussion of the special requirements of an automobile dynamo. 3000 w. Auto Jour—April 16, 1910. No. 13440 A.

Maintenance.

Instructions for Caretakers. Albert L. Clough. Detailed instructions for regular care. 1500 w. Horseless Age—April 20, 1910. No. 13587.

Materials.

Automobile Materials. John Coapman. Gives data collected relating to the analyses and heat treatment of material used. 2500 w. Horseless Age—March 30, 1910. No. 12904.

Mandalay.

The Mandalay "Seventeen." Illustrated description of a small car of the M M class of British build. 1600 w. Auto Jour—March 26, 1910. No. 12921 A.

Metallurgique

The 12-14 H. P. Metallurgique Transmission. Illustrated description. 1000 w. Auto Jour—April 9, 1910. No. 13147 A.

Midland.

Midland Model L Forty Horse Power Car. Illustrates and describes a 1910 model. 1500 w. Horseless Age—April 13, 1910. No. 13122.

Motor Cooling.

In the Solution of Some Radiator Problems. Reviews developments in automobile radiators, and discusses difficulties.

Ills. 1500 w. Automobile—April 21, 1910. No. 13294.

An Investigation of Motor-Cooling Devices (Untersuchung von Automobilkühlern). Walther v. Doblhoff. Describes methods of testing the efficiency of radiators and gives results. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—March 19, 1910. No. 13513 D.

Motor Lubrication.

Lubrication for Internal Combustion Engines. G. H. Baillie. Read before the Royal Automobile Club. Discusses the systems of lubrication, and advantages and disadvantages of forced lubrication. 3000 w. Autocar—March 26, 1910. No. 12919 A.

Motor Power.

Loss of Power in the Motor Car Engine. Donald Hampson. Explains the chief troubles causing power loss. 1800 w. Horseless Age—April 6, 1910. No. 13016.

Motor Rating.

On the Rating of Petrol Engines for Competition Purposes. G. A. Burls. Gives the arguments favoring the stroke-bore ratio theory, and refers to other considerations of interest. 1800 w. Auto Jour—April 9, 1910. No. 13148 A.

Motors.

The Phantom of Flexibility. Considers the limitations of the petrol motor and the possibilities of further improvements in variable speed gears. Also editorial. 2500 w. Autocar—April 2, 1910. No. 13037 A.

Gas Displacement in Two Cycle Cylinders. F. E. Watts. Describes apparatus used and experiments made by the writer. 1200 w. Horseless Age—March 30, 1910. No. 12903.

Motor Starting.

Starting Crank Design. F. E. Watts. Considers some of the causes which affect the starting of a motor and develops a formula for the proper length of starting crank. 1600 w. Horseless Age—April 27, 1910. No. 13586.

Motor Testing.

The Progressive Testing of Motors and Cars. Illustrates and describes the scheme employed by the Regal Motor Car Co., Detroit, Mich. 1200 w. Automobile—April 28, 1910. No. 13581.

The Testing of Automobile Engines on a Commercial Basis. Illustrates and describes factory tests which demonstrate the actual performance. 1300 w. Ir Trd Rev—April 7, 1910. No. 12971.

Test of 20-H.P. Franklin Air-Cooled Motor. R. P. Lay and L. R. Evans. Tests made to determine the variation in volumetric efficiency caused by changing the timing, the shape and size of the valves and the material used for the cooling fins. Ills. Curves. 2500 w. Sib Jour of Engng—April, 1910. No. 13541 C.

Test of Franklin Air-Cooled Motor. L. R. Evans and R. P. Lay. A study of the variation in the volumetric efficiency of the motor caused by changing the timing, the shape and size of the valves, and the material used for the cooling fins. 2500 w. Automobile—March 31, 1910. No. 12806.

Motor Valves.

Overhead Valve Arrangements. Frederick Strickland. Drawings and descriptions of various arrangements, discussing the form of combustion chambers of gasoline motors, and comparing the advantages. 3000 w. Horseless Age—March 30, 1910. No. 12905.

Omnibuses.

Motor Omnibuses for Transportation in Urban Communities (I Servizi di Trasporto in Comuni urbani con Omnibus automobili). U. Baldini. Discusses the development of motor omnibuses and their economy as a means of public transportation. Ills. Serial. 1st part. 4000 w. Ing Ferro—March 16, 1910. No. 13352 D.

Repairs.

Rattling Noises in Cars and Their Prevention. Albert L. Clough. Discusses causes and the remedy. 2000 w. Horseless Age—April 20, 1910. No. 13400.

Pointers in Repair Work—Referring Specifically to Valves. Methods and materials are discussed. Ills. 2200 w. Automobile—April 14, 1910. No. 13114.

Sleighs.

Wolseley Sleighs for the South Pole. Illustrated description of the motor sleighs constructed for Captain Scott to assist him in his projected dash for the south pole. 800 w. Auto Jour—April 2, 1910. No. 13039 A.

Automobiles with Snow Runners (Automobile à Patins pour la Circulation sur la Neige). E. Girardault. Describes various systems of propulsion, particularly the La Besse. Ills. 3500 w. Génie Civil—March 5, 1910. No. 13334 D.

Speedwell.

Speedwell. Illustrated detailed description of the Speedwell cars, especially the "Speedwell 50." 2000 w. Automobile—April 21, 1910. No. 13203.

Stearns.

Stearns. Illustrated descriptions of the Model 30-60, and the general characteristics of other Stearns models. 1800 w. Automobile—April 28, 1910. No. 13580.

Steering Gears.

Angles of Steering Knuckle Arms. Herbert C. Snow. Gives calculations for determining the proper angle, illustrating by examples. 2000 w. Horseless Age—April 13, 1910. No. 13121.

Tires.

Does It Pay to Retread Tires? Charles B. Hayward. A discussion of both theory and practice. 3000 w. Horseless Age—March 30, 1910. No. 12902.

Transmissions.

Frictional Drive. Albert L. Clough. Explains the friction drive and the advantages claimed. 1200 w. Horseless Age—April 6, 1910. No. 13017.

COMBUSTION MOTORS.

Aeronautic Motors.

Development of Motors for Aeroplane Requirements. Augustus Post. Interesting designs and constructions are illustrated and described. 1500 w. Am Mach—Vol. 33. No. 14. No. 12953.

Suggestions in the Design of Aeronautic Motors. Harry E. Dey. Suggestions from the writer's experience, giving a general outline. 3500 w. Mach, N Y—April, 1910. No. 12901 C.

Light and Reliable Gas Engines. A. S. Atkinson. Discusses the principles of the design of gas engines for airships and aeroplanes. 1700 w. Mach, N. Y—April, 1910. No. 12897 C.

New Rotary Gas Engine for Aerial Navigation. Chester L. Lucas and John J. Ross. The L. A. W. 30 H. P. gas motor is illustrated and described. 2000 w. Mach, N Y—April, 1910. No. 12894 C.

Carburetors.

Carburetors and Vaporizers. Charles A. Schranz. Discusses their design and use. 1500 w. Mach, N Y—April, 1910. No. 12900 C.

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engines.

General Maintenance and Special Troubles. R. H. Thomas. Read before the Nat. Com. Gas Assn. Especially emphasizes the need of cleanliness and lubrication. 2500 w. Gas Engine—April, 1910. No. 12961.

Gas Engines in City Railway and Lighting Service. E. D. Latta, Jr. Describes the apparatus and equipment of the Charlotte (N. C.) Electric Railway Co., using gas engines for prime movers, giving report of reliability, efficiency and adaptability, with data of producer gas manufacture, and remarks on the adaptability of gas engines to certain kinds of work. Ills. 8800 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13231 F.

See also Internal-Combustion Engines, under MARINE AND NAVAL ENGINEERING.

Power Plants.

Gas Engines in Competition with Central Station Electric and Isolated Steam Plants. W. W. Cummings. Read before the Nat. Com. Gas Assn. Discussing matters of interest in developing the gas engine industry. Also general discussion. 8000 w. Pro Age—April 15, 1910. No. 13098.

See also Costs, under POWER AND TRANSMISSION.

Gas Producers.

Bituminous Gas Producers. Discussion of J. R. Bibbins' paper. 4000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13244 F.

Testing Suction Gas Producers. Discussion of paper by C. M. Garland and A. P. Kratz. 5000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13243 F.

Suction Gas Producers Using Peat as Fuel (Gasogeni ad Aspirazione per Torba fangosa). Ugo Giribaldi. Describes a number of installations, with data of results. Ills. 2000 w. Industria—March 6, 1910. No. 13346 D.

Oil Engines.

Some Experiments on a Diesel Engine. William Ernest Fisher, and Edmund Baddeley Wood. Describes experiments made with an engine of the Diesel type at various compressions, and with different fuels. Ills. 5000 w. Inst of Civ Engrs—(Students' paper. No. 629.) No. 13276 N.

Three-Years' Record From a Diesel Engine Plant. J. J. Wagoner. Gives results obtained in a 450-h.p. Diesel engine plant, which replaced a compound-engine belt-driven steam plant. 800 w. Power—April 19, 1910. No. 13183.

Danish Petroleum and Crude Oil Motors. Axel Holm. Drawings and description. Ills. 2000 w. Int Marine Engng—April, 1910. No. 12817 C.

Rating.

Commercial Ratings for Internal Combustion Engines. William D. Ennis. Gives an analysis of the factors limiting the output of an engine running under stated conditions. 1600 w. Mach, N Y—April, 1910. No. 12891 C.

HEATING AND COOLING.

Central Plants.

Two Types of Central Heating Plant Compared. Analyzes forced-circulation, hot-water and vacuum steam heating for central plants. 2000 w. Met Work—April 9, 1910. No. 13012.

Refrigeration.

Ice-Making from Exhaust Steam. Illustrates and describes methods used at the plant of the Holdrege, Neb., Lighting Co., which makes ice as a by-product of power generation. 3000 w. Elec Wld—April 7, 1910. No. 12992.

Steam Heating.

A Vapor Vacuum System of Heating. Describes an example of this system. Ills. 2000 w. Met Work—April 9, 1910. No. 13011.

See Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Ventilation.

The Ventilation of Court Rooms and Halls of Justice. William J. Baldwin. Discusses the conditions that prevail and the ventilation necessary. 2000 w. Heat & Vent Mag—April, 1910. No. 13543.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Frank zur Nedden. This fifth and concluding part of a serial considers special high-lift turbo-pumps and their relative economy. Ills. 2000 w. Engineering Magazine—May, 1910. No. 13591 B.

Balanced Multistage Turbo Pumps. Illustrated description of pumps made by the British Electric Plant Co., Ltd. 1600 w. Ir & Coal Trds Rev—April 8, 1910. No. 13178 A.

Turbine Pump in the Low Level Pumping Station, Montreal, Que. A report of the official test. Ills. 1500 w. Can Engr—April 8, 1910. No. 13018.

Compressed-Air Pumping.

Yorkton Compressed Air Water-Works System. F. T. McArthur. Sketches and description of this plant in Canada. 700 w. Can Engr—April 15, 1910. No. 13127.

Design.

Hydraulic Machinery and Appliances. A. Etchells. Read before the Manchester Assn. of Engrs. Remarks on the application of water to mechanical work, and illustrated descriptions of appliances used. 2500 w. Mech Engr—April 8, 1910. Serial. 1st part. No. 13162 A.

Electric Pumping.

Hydroelectric Power as Applied to Irrigation. John Coffee Hays. Considers some of the operating conditions encountered in electrically pumping water for irrigation, describing a typical system. 7000 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13235 F.

Electric Irrigation Pumping in Colorado. E. C. Reybold, Jr. Explains its effect on the summer load curve of the Northern Colorado Power Co. Ills. 2500 w. Elec Wld—April 7, 1910. No. 12991.

Irrigation Pumping. E. C. Reybold, Jr. Reports rates charged for electric service in Colorado. 1800 w. Elec Wld—April 28, 1910. No. 13562.

An Electrohydraulic Pumping Plant. W. A. Clatworthy. From a paper before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of a plant to provide water power for operating various cranes, capstans, lock gates, bridges, etc., in connection with the docks at Bristol, Eng. 1500 w. Elec Rev, N Y—April 9, 1910. Serial. 1st part. No. 13004.

Hydraulic Pressure.

Some Curious Effects of Hydraulic Pressure. F. H. Stillman. Illustrates and describes hydraulic pressure valves cut by jet of water. 1200 w. Am Mach—Vol. 33. No. 15. No. 13085.

Pumping Plants.

See Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Purification, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Theory of Impulse Pumping and Construction of Pumps. John Richards. Illustrates and describes various forms of impulse pumps, discussing the theory. 2200 w. Am Mach—Vol. 33. No. 15. No. 13086.

Notes on the Design and Efficiency of Impulse Pumps. John Richards. Suggestions for reducing cost and increasing efficiency. Ills. 2400 w. Am Mach—Vol. 33. No. 16. No. 13249.

Calculations for the Size of a Pump Beam. Edward M. Bragg. Gives method of calculating the stresses. Mathematical. 1500 w. Int Marine Engng—April, 1910. No. 12816 C.

Turbine Losses.

The Resistance to Rotation of Disks in Water at High Speeds. Arnold Hartley Gibson and A. Ryan. An account of researches to determine the magnitude of the friction at speeds from 600 to 2200 revolutions per minute. Also investigates variation with temperature. 4500 w. Inst of Civ Engrs—No. 3862. No. 13274 N.

Turbine Plants.

See Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbines.

Four 9000-Horsepower Water Turbines. H. Birchard Taylor. Illustrates and describes construction features of the latest development in water turbines, and their increased efficiency and volume. 2500 w. Power—April 19, 1910. No. 13181.

Water Wheels.

The Testing of Water Wheels After Installation. C. M. Allen. Discusses the use of the Alden absorption dynamometer in making brake tests and compares results with computations from the Holyoke tests. Ills. 3500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13238 F.

MACHINE ELEMENTS AND DESIGN.

Crankshafts.

The Calculation of Crankshafts for Internal Combustion Engines. D. O. Barrett. Gives formulae for determining the diameters, sizes of bearings, and dimensions of cheeks. 900 w. Mach, N Y—April, 1910. No. 12802 C.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

Aluminium Gas Engine Cylinders. Illustrates and describes the method of their production and discusses how the shrinkage problem was overcome. 1200 w. Foundry—April, 1910. No. 12913.

Making Gas Engine Cylinders in Aluminum. Illustrates and describes the method of production. 1500 w. Ir Trd Rev—March 31, 1910. No. 12807.

Automatic Machines.

Davenport Multi-spindle Automatic Screw Machine. Illustrated detailed description of the general features. 2500 w. Am Mach—Vol. 33. No. 15. No. 13081.

Boring.

Some Work Performed on Huge 60-foot Boring Mill. Robert Reid. Illustrates and describes a variety of operations on extra large work. 1000 w. Am Mach—Vol. 33. No. 16. No. 13246.

Brass Founding.

The Chemist in the Brass Foundry. W. M. Corse. Read before the Am. Chem. Soc. On the development of the chemical laboratory in connection with brass foundries. 1200 w. Brass Wld—April, 1910. No. 13430.

Equipment of a Modern Brass Shop. C. Vickers. The construction and general arrangement is illustrated and described, including a description of novel tilting oil furnaces and ladle heaters. 3500 w. Foundry—April, 1910. No. 12916.

Case Hardening.

On Practical Methods of Casehardening. E. R. Markham. Considers various examples. 2500 w. Mech Wld—April 1, 1910. No. 13053 A.

Castings.

"Casting-On" Liners on Iron Pump Rams, Etc. Walter J. May. Describes the work. 800 w. Mech Wld—April 8, 1910. No. 13163 A.

Cupola Practice.

Cupola Practice (Kupolofen-Betrieb). A. Koob. A general review of practical points in cupola operation. 3000 w. Giesserei-Zeit—March 15, 1910. No. 13366 D.

Air Supply in the Design and Operation of Cupola (Die Luftmenge und ihre Bedeutung für den Bau und Betrieb der Kupolofen). Georg Buzek. An exhaustive discussion of the problem of air-supply in cupola practice. Ills. Serial. 1st part. 6500 w. Stahl u Eisen—March 2, 1910. No. 13354 D.

Cutting Metals.

The Cutting of Metals by Oxidation. James Aston. Considers cutting by the oxyhydrogen or oxyacetylene blow pipe. 2000 w. Wis Engr—April, 1910. No. 13198 D.

Drilling Machines.

High-Speed Universal Radial Drilling Machine. Illustrated description of a design manufactured in England. 800 w. Mech Engr—April 8, 1910. No. 13161 A.

Forging Hammers.

Electrically Driven Drop Hammers. Illustrated detailed description of new designs and their operation. 2000 w. Engr, Lond—March 25, 1910. No. 12941 A.

Foundries.

See Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Foundry Coke.

Coke for Foundry Purposes. E. L. Rhead. Read before the British Found. Assn. Discusses the qualities required to secure the best results. 1500 w. Prac Engr—April 1, 1910. No. 13048 A.

Foundry Design.

Fire Prevention in Foundries. Sidney G. Walker. Presents the advantages of the sprinkler system and proper plant construction. 4500 w. Foundry—April, 1910. No. 12914.

Grinding.

Cam Grinding. H. T. Shearer. Illustrated description of new grinding equipment. 1500 w. Ir Trd Rev—March 31, 1910. No. 12808.

Lathes.

A Large Sliding, Surfacing and Boring Lathe. Illustrated description of a large lathe designed for dealing with all kinds of heavy forgings and steel castings. 1000 w. Engr, Lond—April 15, 1910. No. 13469 A.

102-In. Surfacing and Screw-Cutting Lathe. Illustrated description of an unusually large lathe. Plate. 8000 w. Engng—March 25, 1910. No. 12935 A.

Turret Lathe with Ball Bearings. Illustrated description of a 10½-inch centres turret lathe, with report of tests. 1200 w. Engr, Lond—April 15, 1910. No. 13471 A.

Speed-Changing Gears (Ueber die Wirtschaft des Radabdrehens). Herr Lamm. A discussion of progress in this field. Ills. Serial. 1st part. 1700 w. Glasers Ann—March 1, 1910. No. 13395 D.

Molding.

Plaster False Backs for Hand Molding. Walter J. May. Describes these devices and their use. Ills. 800 w. Mech Wld—April 1, 1910. No. 13052 A.

Planing Machines.

The Work of Planing Machines (Note sur le Travail des Raboteuses). E. Gueneau. A mathematical discussion of their power requirements. 3000 w. All Indus—March, 1910. No. 13330 D.

Screw Making.

Principles of Thread Rolling and the Setting of the Dies. J. F. Springer. Explains the action of a thread rolling die, the setting of the die, and related processes. 2500 w. Am Mach—Vol. 33. No. 16. No. 13250.

Shop Appliances.

Fixtures for Machining Eccentric Piston Rings. C. T. Schaefer. Illustrations and brief description. 700 w. Mach, N Y—April, 1910. No. 12896 C.

Shop Design.

Some Serious Defects of Machine Shop Construction and Equipment. Oscar E. Perrigo. Calls attention to some of the faults observed and curious arrangements. 3000 w. Ir Trd Rev—April 7, 1910. No. 12972.

Light, Ventilation and Drainage in One-Story Shop Design. Drawings and description of two designs, adapted to climatic conditions in the north. 1600 w. Mach, N Y—April, 1910. No. 12893 C.

Shop Heating.

A Modern Shop-Heating System (Eine moderne Fabrikheizung). Max Hottinger. Describes the steam-heating system of a large German works. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—March 26, 1910. No. 13515 D.

Shop Lighting.

Machine Shop Lighting. E. B. Rowe. An illustrated study of general shop illumination and the local lighting of machines. 1200 w. Ir Age—April 21, 1910 No. 13280.

Shop Practice.

The Influence of Improved Materials and Methods of Production on Shop Practice (Einfluss der Verbesserung des Materials—Eisen—und der Herstellverfahren auf den Fabrikbetrieb). C. Prinz. A general review of improvements in the metalworking field. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—March 19, 1910. No. 13512 D.

The Manufacture of Wheels and Axles for Railway Rolling Stock. Illustrates and describes the process of manufacture. 1200 w. Mech Wld—March 25, 1910. Serial. 1st part. No. 12932 A.

Machining Gas Engine Flywheels, Cylinders and Beds. Ethan Viall. The practice of the Foos Gas Engine Co., at Springfield, O., is illustrated and described. 1500 w. Mach, N Y—April, 1910. No. 12895 C.

Special Tools and Methods Used in a Planer Building Shop. Illustrates and describes processes and devices used to advantage in a Cincinnati shop. 1500 w. Am Mach—Vol. 33. No. 14. No. 12952.

Automobile Building Details That Produce Good Results. Illustrates and describes modern practice in milling, grinding, boring, broaching, and turning operations. 2000 w. Am Mach—Vol. 33. No. 14. No. 12950.

Some of the Methods Used in Building the Locomobile. Fred H. Colvin. Illustrates and describes fixtures and tools for handling the various parts. 2500 w. Am Mach—Vol. 33. No. 17. No. 13552.

Advanced Methods Obtain in the National Plant. Thomas J. Fay. Illustrates and describes methods employed in manufacturing the National motor vehicles. 1500 w. Automobile—April 14, 1910. No. 13113.

Shop Kinks from the Elizabethport Shops of the Central Railroad of New Jersey. F. E. Lister. Descriptions with 44 illustrations. 8500 w. Ry Age Gaz—April 1, 1910. No. 12886.

Tempering.

The Tempering of Steel. William Manktelow. Considers temperatures of fusible alloys suitable for tempering steel. 800 w. Prac Engr—March 25, 1910. No. 12926 A.

Gear Hardening Practice at the Light Mfg. and Foundry Co. Information concerning the making of chrome-nickel steel gears. Ills. 1000 w. Am Mach—Vol. 33. No. 16. No. 13248.

Welding.

The Autogenous Welding of Metals. Illustrated review of the development of this process. 3000 w. Ir Trd Rev—April 14, 1910. No. 13117.

Some Recent Boiler Repairs by the Oxy-Acetylene Process. Successful applications of this process are illustrated and described. 1500 w. Boiler Maker—April, 1910. No. 12977.

Autogenous Welding (Observations sur la Soudure autogène). A letter from A. Le Chatelier criticizing Ch. Fremont's paper in *Génie Civil* for Feb. 28, 1910, with M. Fremont's reply. 2200 w. Génie Civil—March 19, 1910. No. 13339 D.

Wire Drawing.

The Humphrey Wire Drawing Machine. Illustrated description. The special features are its friction clutch, die threading device, wire block construction and the provisions for the safety of the operator. 3000 w. Ir Age—April 28, 1910. No. 13565.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Steels. Leon Guillet. Read at fifth congress of Int. Assn. for Test. Mat. Reviews recent progress and the steels of importance for structural purposes. 2000 w. Mech Engr—April 1, 1910. No. 13051 A.

Report on the Question of the Use of Steel. Special Steels (Subject V, Littera B, for Discussion at the Eighth Session of the Railway Congress). R. L. Ettenger. Considers the use of special steel of high resistance in the making of the various parts of locomotives and rolling stock in America. Ills. 2800 w. Bul Int Ry Cong—March, 1910. No. 13485 G.

Cast Iron.

The Composition and Manufacture of Malleable Cast Iron (Sur la Composition et la Fabrication de la Fonte Malléable). R. Namias. From *Rassegna Mineraria*. Serial. 1st part. 1300 w. Métallurgie—March 23, 1910. No. 13333 D.

Metallography.

Segregation in Steel Castings. S. S. Knight. Discusses the value of microscopy and synthetic chemistry in metallographic investigations. 4000 w. Foundry—April, 1910. No. 12915.

Metallographic Investigation of a Skip Bale (Metallographische Materialuntersuchung eines Kübelbügels). H. Winter. Describes an investigation of a bale which failed in service. Ills. 1500 w. Glückauf—March 5, 1910. No. 13372 D.

See also Steel, under MATERIALS OF CONSTRUCTION.

Metal Shrinkage.

The Shrinkage of Metals and Alloys. From an article by Prof. F. Wuest in *Metallurgie*. Describes an ingenious method of accurate measurement, giving tabulated results with various non-ferrous groups. 1000 w. Ir Age—April 7, 1910. No. 12945.

Refractory Materials.

See same title, under MINING AND METALLURGY, Miscellany.

Steel.

Oxygen, Hydrogen and Nitrogen in Steel. E. F. Lake. Gives results of tests showing the effect of oxygen on blistering. 1500 w. Am Mach—Vol. 33. No. 14. No. 12951.

The Brittleness of Mild Steel Due to Nitrogen. C. E. Stromeyer. Read before the Inst. of Naval Archts. A report of experimental investigations with mill steel plates to ascertain whether any mechanical tests could be relied on to determine quality. 2500 w. Ir & Coal Trds Rev—March 25, 1910. No. 12942 A.

Some Remarks Upon the Critical Points of Steel, Their Method of Determination and the Value of Same. George W. Sargent. An illustrated article considering methods of determining these critical points, and giving a study of cooling curves and heating curves. 2000 w. Jour Fr Inst—April, 1910. No. 13533 D.

The Action of Steam on Iron. J. Newton Friend. Gives results of experiments and discusses their value. Ills. 3500 w. Jour W of Scotland Ir & St Inst—Dec. 17, 1910. No. 13531 N.

The Behavior of Ductile Material Under Torsional Strain with Restoration of Elasticity at Low Temperatures. Charles Edward Larard. A detailed account of experiments made to investigate behavior. 3500 w. Inst of Civ Engrs—No. 3848. No. 13275 N.

The Influence of Sudden Changes of Temperature on Mild Steel (Recherches sur l'Influence des brusques Changements de Température sur l'Acier doux). Bruno Zschokke. A report of experimental researches. Ills. 6200 w. Rev de Métal—March, 1910. No. 13316 E + F.

Tool Steel.

High Speed Steel and Its Heat Treatment. W. G. Smith. Extracts from an article in *The Armour Engr.* Explains the influence of various elements and the effects of treatment. 2200 w. Eng News—April 21, 1910. No. 13258.

Unusual Results Obtained by the Use of High Speed Steel. C. Berg. Gives report of a series of tests to determine its exact cutting capabilities under certain conditions. 2000 w. Am Mach—Vol. 33. No. 15. No. 13082.

MEASUREMENT.

Dynamometers.

The Measurement of Power: a New Transmission Dynamometer (La Mesure des Puissances: un nouveau Dynamomètre de Transmission). A. Bocquet. Describes the invention of M. André Wallon. Ills. 2000 w. Rev d'Econ Indus—March 20, 1910. No. 13301 D.

See also Water Wheels, under Hydraulic Machinery.

Gas Meters.

An Electric Gas Meter. Discussion of Carl C. Thomas's paper on this subject. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13240 F.

Hardness.

Amsler Hardness Testing Machine and Cone Attachment. Illustrated description of a machine manufactured in Switzerland, for testing by the Brinell ball method; and an appliance for employing the Ludwik cone method. 900 w. Am Mach—Vol. 33. No. 15. No. 13083.

Laboratories.

Notes On Some European Testing Laboratories. An account by an engineer based on inspection of the laboratories of the technical high schools at Zurich, Stuttgart, Munich, Dresden, and the laboratory at Gros-Lichterfelde near Berlin. 2000 w. Eng News—April 28, 1910. No. 13570.

Testing Methods.

Lecture on "Some Points Regarding the Testing of Iron and Steel." Archibald Barr. Considers tensile tests of iron and steel. Ills. 8000 w. Jour W of Scotland Ir & St Inst—Oct. 22, 1909. No. 13529 N.

POWER AND TRANSMISSION.

Air Compressors.

Application of Low-Pressure Steam Turbines to Compressor Work. J. W. Sheperdson. Gives original output and economy data from a working installation. 3000 w. Engineering Magazine—May, 1910. No. 13594 B.

Cobalt Hydraulic Air Compressor. C. H. Taylor. Illustrated description of the Taylor air-compression system at Ragged Chutes, on the Montreal River, Canada. 2500 w. Mines & Min—April, 1910. No. 12863 C.

A Comparison Between a Piston Compressor and a Turbo-Compressor (Comparaison entre un Compresseur à Pistons et un Turbo-Compresseur). A review of Havlick's paper in the *Zeitschrift des Vereines Deutscher Ingenieure.* Ills. Serial. 1st part. 1800 w. Rev Indus—March 5, 1910. No. 13331 D.

Recent Borsig Air Compressors (Neuere Luftkompressoren der Maschinenfabrik A. Borsig). Herr Schwanecke. Describes a number of improvements and recent machines. Ills. 3700 w. Glückauf—March 26, 1910. No. 13378 D.

Belting.

A Systematic Solution of the Belting Problem. William H. Taylor. Illustrated description of an improved belt bench arranged to determine the length and weigh the tension in belts, with directions for using. Also remarks on the care of belting. 4500 w. Am Mach—Vol. 33. No. 17. No. 13551.

The Transmission of Power by Belts. R. Krall. Abstract of a paper read at meeting of Inst. of Engrs. Considers details of belt drives, and gives some results of experiments with steel belts in the present number. 1800 w. Prac Engr—April 1, 1910. Serial. 1st part. No. 13046 A.

Compressed Air.

Engine Driving by Compressed Air. Snowden B. Redfield. A theoretical study of a system in which current from a long distance transmission line drives a motor operated compressor supplying the engine with air which is reheated on its way to the cylinder. 4000 w. Power—April 5, 1910. No. 12910.

Costs.

Cost of Power for Various Industries Under Ordinary Conditions. Charles T. Main and F. M. Gunby. Explains some of the reasons for the very great differences in the cost of power under various circumstances. 6500 w. Jour Assn of Engng Socs—March, 1910. No. 13526 C.

A Practical Study of Power Costs. William O. Webber. Gives a report showing how actual costs were determined. 2000 w. Engineering Magazine—May, 1910. No. 13593 B.

Operating Costs of a Gas Power Plant and a Mixed Steam Engine and Turbine Plant (Betriebskosten einer Gas- und einer aus Kolbenmaschinen und Dampfturbinen gemischten Dampfkraftanlage). W. Heym. A comparison of the two types. Ills. 2500 w. Die Turbine—March 5, 1910. No. 13382 D.

Electric Driving.

Economical Features of Electric Motor Applications. Charles Robbins. Shows how a problem in motor drive can be handled in order to show its maximum economy. 11000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13245 F.

Mechanical Features of Electric Driving in Machine Shops. John Riddell. Deals especially with the electrical equipment of machine tools in the plant of the General Electric Co., at Schenectady, N. Y. Ills. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13230 F.

Electric Drive in Textile Mills. Albert Milmow. Deals especially with the employment of electric power, derived from hydroelectric systems of distribution, for the operation of textile mills, giving a series of curves taken with a delicate recording tachometer. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13230 F.

The Driving of Textile Factories. A Comparison Between Electric and Steam Rope Driving. L. Crouch. 5000 w. Elec Rev, Lond—April 15, 1910. No. 13455 A.

Electric Individual Drive in Continental Textile Mills. W. R. Rothenberg. Illustrated description of plant and equipment of all machines on the single drive system. 2500 w. Elec Rev, Lond—April 15, 1910. Serial. 1st part. No. 13456 A.

See also Cranes, under TRANSPORTING AND CONVEYING.

Gas Power.

See Gas Power Plants, under COMBUSTION MOTORS.

Lubricants.

Graphite as a Lubricant. Illustrated description of a graphite lubricator, manufactured in England. 1500 w. Engr, Lond—April 15, 1910. No. 13468 A.

Mechanical Power.

The Influence of Mechanical Power. Charles Edward Lucke. Abstract of last Hewitt lecture, at Cooper Union. Discusses its effect on present-day conditions. 1800 w. Power—April 12, 1910. No. 13029.

Piping Systems.

Identification of Piping Systems by Means of Colors (Die Kennzeichnung von Rohrleitungen im Fabrikbetriebe mittels Farben). Gives a chart of colors, suggesting additions to the scheme proposed by W. H. Bryan. Ills. 2000 w. Stahl u Eisen—March 9, 1910. No. 13355 D.

STEAM ENGINEERING.

Boiler Corrosion.

Boiler Corrosion. A study of electrochemical action with remarks on the experiments carried out by Prof. C. F. Burgess. 2500 w. Sci Am Sup—April 23, 1910. No. 13268.

Boiler Design.

Something About Boiler Stress Formulas. Charles J. Mason. Explains the more important formulae in use. 700 w. Boiler Maker—April, 1910. No. 12978.

Boiler Fittings.

Boiler Attachments and Funnel Draft. H. K. Spencer. Suggestions relating to attachments necessary to the operation of boilers, and a study of combustion and draft. 3500 w. Boiler Maker—April, 1910. No. 12979.

Boiler Furnaces.

A Smokeless Soft Coal Furnace. T. T. Parker. Illustrates a type of furnace for horizontal tubular boilers which has successfully prevented smoke. 1000 w. Power—April 19, 1910. No. 13185.

Boiler Management.

Combustion of Coal. Lewis Sanders. Discusses how to burn coal economically, and explains the use of the Orsat apparatus for ascertaining the amount of CO_2 in the flue gases. 3500 w. Jour U S Art—March-April, 1910. Serial. 1st part. No. 13288 D.

Boiler Repairs.

See Welding, under MACHINE WORKS AND FOUNDRIES.

Condensers.

Condensing. W. H. Booth. Brief discussion of condensers and present practice. 1200 w. Elec Rev, Lond—April 8, 1910. No. 13155 A.

Condenser Tubes and Circulating Water. Nathan Owitz. States briefly the advantages claimed for various types of condenser tubes, discussing also methods of cleaning. 1500 w. Power—April 12, 1910. No. 13027.

English Practice in Condensing Equipment. James A. Seager. Describes and illustrates the Leblanc system, air and circulating pumps of recent design, and systems of electric drives for condenser auxiliaries. 3000 w. Power—April 19, 1910. No. 13184.

English Practice in Condensing Equipment. James A. Seager. Illustrates and describes the contraflo condenser, the Parsons vacuum augmenter, and recent developments in the jet condenser of different types. 2500 w. Power—April 5, 1910. No. 12912.

Economizers.

See Feed-Water Heaters, under Steam Engineering.

Engine Economy.

See Central Stations, under ELECTRICAL ENGINEERING, Generating Stations.

Engine Erection.

The Erecting and Testing of a High-Speed Engine. W. S. Douglas. Prize paper. Considers the round of operations in erecting and testing. Ills. 2600 w. Mech Wld—April 15, 1910. Serial. 1st part. No. 13442 A.

Engine Governing.

Governing Rolling Mill Engines. Discussion of W. P. Caine's paper. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13241 F.

Engines.

1500-Brake-Horse-Power High-Speed Steam-Engines. Plates and description of the engines for a power-house at Bahia Blanca, Argentina, for the Buenos Aires and Pacific Ry Co. 1500 w. Engng—March 25, 1910. No. 12937 A.

Engine Testing.

See Engine Erection, under Steam Engineering.

Feed Water Heating.

Feed Water Heaters and Economizers. William F. Fischer. Discusses the effect of oil and scale forming matter in open heaters; the live-steam feed-water heaters and purifiers, and the saving from using economizers. 1800 w. Power—April 26, 1910. No. 13476.

Feed Water Heaters of the Closed Type. William F. Fischer. Gives saving due to heating feed water by exhaust steam in closed heaters, and effect of scale and oil. 3000 w. Power—April 19, 1910. No. 13180.

Flue Gas Analysis.

See Boiler Management, under Steam Engineering.

Fuel Purchasing.

The Purchase of Coal for the Department of Water Supply, Gas and Electricity of New York City. J. Leggett Pultz. Including a description and criticism of several forms of coal contracts and specifications, the coal consumption of the city departments, and a proposed uniform and systematic method of purchasing coal. 13000 w. Dept of Water Supply, N Y—April, 1910. No. 13269 N.

Fuels.

Unit Coal and the Composition of Coal Ash. S. W. Parr and W. F. Wheeler. Presents results of investigations upon the properties of actual coal as distinguished from the mineral constituents. 11500 w. Univ of Ill, Bul No. 37—Aug. 9, 1909. No. 12959 N.

Fuel Oil. E. N. Percy. Deals with the extent of the world's supply and its effect on cost as compared with coal. 3000 w. Int Marine Engng—April, 1910. Serial. 1st part. No. 12819 C.

See also Coke-Oven Gas, under MINING AND METALLURGY, Coal and Coke.

Smoke Prevention.

Smoke Prevention in Steam Boiler Plants. H. D. Frary. (Second article.) Illustrates and describes special methods and appliances for preventing smoke, and discusses conditions in large cities. 6000 w. Minn Engr—March, 1910. No. 13076 C.

Superheating.

The Effect of Superheated Steam on Cast Iron and Steel. Albert A. Cary. Calls attention to precautions necessary in installations. 2500 w. Ir Age—April 7, 1910. No. 12946.

Turbine Nozzles.

Efficiency Tests of Steam Nozzles. Discussion of paper by F. H. Sibley and T. S. Kemble. 4500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13242 F.

Turbine Plants.

Plant of Pfister & Vogel Leather Co. Osborn Monnett. Illustrates and describes a modern turbine plant designed for limited space and economical operation. 2000 w. Power—April 5, 1910. No. 12909.

See also Central Stations, under ELECTRICAL ENGINEERING, Generating Stations.

Turbines.

The Relation of the Steam Turbine to Modern Central Station Practice. G. R. Parker. Reviews steam turbine principles, especially considering the Curtis impulse turbine as perfected by Emmet. General discussion. 8000 w. Jour Assn of Engng Socs—Feb., 1910. No. 12962 C.

The Oerlikon Series-Parallel Steam Turbine (Die Oerlikon-Serie-Paralleldampfturbine). W. Koeniger. Describes a turbine for use with either live or exhaust steam. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13384 D.

Recent Eyermann Steam Turbines (Neuere Eyermann-Dampfturbinen). Describes and illustrates recent examples of this type of turbine. 1800 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13387 D.

See also Air Compressors, under POWER AND TRANSMISSION.

Valve Setting.

Setting Link Driven Valves. Warren O. Rogers. Explains the setting of slide valves of hoisting engines driven by link motion and two eccentrics. Ills. 2500 w. Power—April 12, 1910. No. 13025.

TRANSPORTING AND CONVEYING.

Coal Handling.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Cranes.

An Old-Time Crane. F. G. Haldy. Brief illustrated description of an old treadmill crane at Treves, Germany. 500 w. Cassier's Mag—April, 1910. No. 13195 B.

The Crane Equipment of the Hamburg Branch of the Vulcan Works, Stettin (Die Hellinganlage des Stettiner Vulcan, Zweigniederlassung Hamburg). A. Cyran. Detailed description. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—March 5, 1910. No. 13508 D.

Electric Driving of Machines of Intermittent Operation, with Particular Reference to Cranes (Note sull' Azionamento elettrico delle Macchine a Funzionamento intermittente ed in Particolare delle Gru). E. Sacerdote. Discusses the choice of motors for this service. Ills. 3800 w. Ann d Soc d Ing e d Arch Ital—March 1, 1910. No. 13345 F.

Elevators.

The Elevator Installation of the Metropolitan Life Tower. Herbert T. Wade. Illustrated detailed description of the Otis system as installed in a 44-story building. 1500 w. Sci Am—April 30, 1910. No. 13574.

Grain Handling.

See Grain Elevators, under MARINE AND NAVAL ENGINEERING.

Lifting Magnets.

Lifting Magnets in the Foundry. A. C. Eastwood. Abstract of a paper read before the Pittsburg Found. Assn Illustrates and describes a number of applications. 3000 w. Ir Trd Rev—April 21, 1910. No. 13280.

MISCELLANY.

Aerodynamics.

The Installation of an Aerodynamic Laboratory (Installation d'un Laboratoire d'Aérodynamique). M. G. Eiffel. Describes a laboratory equipped by the author for the study of air resistance, the methods of experiment, and results obtained. Ills. 11500 w. Mem Soc Ing Civ de France—Jan., 1910. No. 13304 G.

Aeronautics.

Motive Flying Machines (Motor-Flugmaschinen). Johann Trnovsky. A review of the leading types of airships and aeroplanes. Ills. 8500 w. Oest Wochenschr f d Oeffent Baudienst—March 5, 1910. No. 13500 D.

Aviation (L'Aviation). Commandant Paul Renard. The first part of the serial discusses the fundamental principles of aeronautics. Serial. 1st part. 11000 w. Rev Gen des Sci—March 15, 1910. No. 13319 D.

Longitudinal Equilibrium and Curvature of Aeroplane Planes (L'Equilibre longitudinal et la Courbure des Surfaces portantes des Aéroplanes). René Arnoux. A theoretical discussion. Ills. 6500 w. Mem Soc Ing Civ de France—Jan., 1910. No. 13305 G.

Aeronautic Progress Along Constructive Lines. Marius C. Krarup. The first of a series of articles discussing aeronautic construction. 1000 w. Automobile—April 14, 1910. Serial. 1st part. No. 13115.

The Construction of Aeroplanes. The present article gives an illustrated description of the latest Farman biplane. 2500 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13171 A.

The Military Aspect of Dirigible Balloons and Aeroplanes. J. E. Capper. Reviews briefly the progress made and probable developments, discussing how best to utilize these machines. Discussion. 3500 w. Jour U S Art—March-April, 1910. No. 13285 D.

A Possible Use for Aeroplanes in War Suggested by Witnessing Their Flight at Los Angeles. S. F. Bottoms. Discusses their use for dropping high explosives on hostile forts or armies in the field. 600 w. Jour U. S Art—March-April, 1910. No. 13283 D.

The Wright Flyer and Its Possible Uses in War. F. E. Humphreys. Considers the uses from a military stanpoint. Ills. 2000 w. Jour U S Art—March-April, 1910. No. 13284 D.

The Olympia Aero Exhibition. W. S. Aston. Illustrated description of the show and some of the notable exhibits. 2000 w. Sci Am Sup—April 9, 1910. No. 12984.

The First Aviation Meet in America. Leroy W. Allison. A record of the performances and an illustrated description of the machines. 3800 w. Mach, N Y—April, 1910. No. 12899 C.

Bread Making.

Bread Making by Machinery (La Panification mécanique). L. Ammann. Discusses the hygienic importance of the employment of machinery in bread making and describes various machines. Ills. 5000 w. Bul Soc d'Encour—Feb., 1910. No. 13318 G.

Guns.

The Life and Power of Heavy Ordnance. Editorial reply to criticisms of an earlier article on the efficiency of guns and matters related. 3000 w. Engng—April 15, 1910. No. 13465 A.

Airship Guns. Illustrates and describes guns developed by Krupps and by the Ehrhardts to contend against airships. 1000 w. Jour U. S. Art—March-April, 1910. No. 13286 D.

Safety Devices.

The Protection of Employees in Cotton Mills. H. M. Crawford. Illustrates and describes methods of fencing self-acting mules. 2500 w. Cassier's Mag—April, 1910. No. 13193 B.

Textile Machinery.

Calico Printing Mechanism. James Robinson. Reviews the mechanism employed in a modern calico printing works. Ills. 18500 w. Manchester Assn of Engrs. (Adv Copy)—March 12, 1910. No. 13491 N.

Weaving Appliances. Frank Nasmith. Read before the Manchester Assn. of Engrs. Describes the essential operative mechanisms, and appliances for the purpose of increasing production. Ills. 1600 w. Mech Engr—March 25, 1910. Serial. 1st part. No. 12931 A.

See also Safety Devices, under Miscellany.

Textile Mills.

A Modern Cotton Mill. An illustrated detailed description of one of the latest Lancashire factories, giving a description of the lay-out and arrangement of the various departments, and describing appliances of special interest. 2500 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13169.

See also Electric Driving, under Power and Transmission.

MINING AND METALLURGY.

COAL AND COKE.

Alaska.

The Alaska Coal Cases. H. V. Winchell. A statement of facts relating to the Cunningham claims in Alaska, and discussion of the attitude of the U. S. Government in regard to their development. 4500 w. Eng & Min Jour—April 23, 1910. No. 13414.

The Controller Bay Coal Field. George Watkin Evans. An estimate of the amount, cost of mining and probable market of coal in this field. Map and Ills. 4000 w. Mines & Min—April, 1910. No. 12867 C.

Australia.

The Geology of Victoria Coal Deposits. T. S. Hart. Presents a "modified drift theory" to explain the Powlett field deposits. 2000 w. Aust Min Stand—March 16, 1910. Serial. 1st part. No. 13487 B.

The Coal Mining Industry of Victoria. An illustrated account of the official opening of the Powlett field, with history of the enterprise. 4000 w. Aust Min Stand—March 16, 1910. No. 13486 B.

Briquetting.

The Fuel-Briquetting Industry. Charles L. Wright. An illustrated article giving a classification of fuel dryers and briquetting machines. 2200 w. Engineering Magazine—May, 1910. No. 13590 B.

Coke-Oven Gas.

The Use of Coke-Oven Gas as Fuel. Thomas J. Brown. Read before the Min. Soc. of Nova Scotia. Gives details of the plant of the Nova Scotia Steel & Coal Co., explaining how the waste gases were utilized as fuel. 2000 w. Can Min Jour—April 15, 1910. No. 13186.

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The Utilization of Germany's Natural Resources (Die Auswertung vaterländischer Bodenschätze). F. E. Junge. A discussion of the importance of by-product recovery in the utilization of coal. 4000 w. Tech u Wirt—March, 1910. No. 13521 D.

The Manufacture of Benzol (La Fabrication du Benzol). A. Grebel. Describes the process of recovery from coke-oven gas. Ills. 4500 w. Génie Civil—March 19, 1910. No. 13338 D.

Electric Power.

An Electrical Safety System for Use in Mines. H. J. Fisher. Illustrated description of a system to reduce the risks attending the use of trailing cables and portable electrically-driven machinery in mines. 2500 w. Elect'n, Lond—April 1, 1910. No. 13044 A.

The Relative Merits of Direct- and Three-Phase Alternating Currents for Colliery Work. C. R. M. Young. Read before the Newcastle Sec. of the Inst. of Min. Elec. Engrs. A comparison of their reliability cost, and flexibility. 4500 w. Ir & Coal Trds Rev—April 8, 1910. No. 13176 A.

Electrical Breakdown in Collieries: Their Cause and Prevention. H. J. Fisher. Read before the Newcastle Branch of the Inst. of Min. Elec. Engrs. Also discussion. Discusses faults on cables due to bad design, faulty operation, machinery, bad work and moisture. 7500 w. Ir & Coal Trds Rev—March 25, 1910. No. 12943 A.

The Electrification of Murton Colliery, County Durham. A descriptive account of the change from steam to electric power. 4000 w. Ir & Coal Trds Rev—April 15, 1910. No. 13474 A.

England.

See Boring, under Mining.

Explosions.

Mine Explosions at Stearns, Ky. Location and description of the mines, and of the peculiar action of the explosive force. Plans. 2200 w. Mines & Min—April, 1910. No. 12870 C.

France.

The Lorraine Coal Basin (Le Bassin houiller de la Lorraine). Gabriel Sepulchre. A detailed report on its extent, importance, development, etc. Ills. 10000 w. Tech Mod—March, 1910. No. 13325 D.

Manchuria.

The Fushun Colliery, South Manchuria. Warden A. Moller. Brief description of sub-bituminous mines now being opened. 1000 w. Bul Am Inst of Min Engrs—April, 1910. No. 13539 F.

Mine Dust.

The Ignition of Coal Dust by Single Electric Flashes. Abstract of a paper by Dr. W. M. Thornton and E. Bowden, before the Inst. of Min. & Mech. Engrs. Discusses results of exhaustive experimental investigations. Discussion. 7000 w. Ir & Coal Trds Rev—April 15, 1910. No. 13473 A.

Mine Fires.

Mine Recovery with Oxygen Helmets. R. Y. Williams. Describes the recovery of the fire-sealed area of the Majestic mine. Ills. 2500 w. Min Wld—April 2, 1910. No. 12881.

Mine Waters.

The Clarification of Pit Effluent Waters. Brief description of methods used in the Westphalian mining district in Germany. 1000 w. Ir & Coal Trds Rev—April 1, 1910. No. 13064 A.

Mining.

Safe Methods of Coal Mining (Die für die Sicherheit der Arbeiter zweckmässigsten Arten des Ausbaues vor Abbauen und der Flözverhiebes beim Steinkohlenbergbau). Dr. Niess. The first part discusses the prevention of falls of roof and coal. Ills. Serial. 1st part. 4500 w. Glückauf—March 19, 1910. No. 13376 D.

Advance and Retreat Room-and-Pillar System. H. J. Nelms. Describes a plan for developing a coal mine on this system. 700 w. Eng & Min Jour—April 23, 1910. No. 13418.

Mining Thick Seams in the Ruhr District (Der Abbau besonders machtiger Flöze im Ruhrbezirk). Herr Unterhössel. Illustrated description of methods. 4000 w. Glückauf—March 5, 1910. No. 13370 D.

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Mining Hygiene.

How European Collieries Are Safeguarded. An account of methods adopted to improve conditions and prevent disease, and precautions to eliminate explosions and increase efficiency. 3000 w. Eng & Min Jour—April 15, 1910. No. 13130.

Mining Royalties.

The Checking of Coal Royalty Accounts. R. Wilson Bartlett. Considers in their order the chief features met with in the usual form of mineral leases. 2800 w. Ir & Coal Trds Rev—April 1, 1910. No. 13062 A.

Mining Wages.

Wages in the German and British Mining Industries (Deutsche und britische Bergarbeiterlöhne). Ernst Jüngst. A statistical review, covering the last quarter-century. 4000 w. Glückauf—March 12, 1910. No. 13375 D.

Washing.

Coal Washing Plant. Illustrated description of a plant with patent conditioning draining machine. 1000 w. Ir & Coal Trds Rev—April 1, 1910. No. 13063 A.

Eliminating Dust from Anthracite Breaker. J. J. Jones. Describes a dust eliminator patented by B. G. Carpenter & Co., stating the advantages claimed. 1000 w. Eng & Min Jour—April 2, 1910. No. 12878.

COPPER.

Analysis.

Methods of Analysis at Cananea Con. Property. Evans W. Buskett. Gives the methods used in the routine analyses of slags, ores, bullion, etc., at the Ronquillo laboratory of the Cananea Consolidated Copper Co., S. A. 4000 w. Min Wld—April 2, 1910. No. 12882.

Arizona.

Courtland, Ariz., and Its Mining Possibilities. Charles A. Dinsmore. An illustrated article giving information concerning the condition of this copper camp. 2500 w. Min Wld—April 9, 1910. No. 13019.

Copper Deposits of the Globe-Kelvin Districts. Edwin Higgins. Describes the geology, the deposits, development work, etc., of districts in Arizona giving promise of valuable production. Maps & Ills. 2000 w. Eng & Min Jour—April 9, 1910. Serial. 1st part. No. 13007.

Australia.

Kyloe Copper Mine, Adaminaby (N. S. W.). Describes the mine and ore-dressing plant. Ills. 2500 w. Aust Min Stand—March 2, 1910. No. 13035 B.

Converters.

See Mattes, under Copper.

Mattes.

The Behavior of Copper-Matte and Copper-Nickel Matte in the Bessemer Converter. David H. Browne. Gives results of experimental study and conclusions. Curves & tables. 2500 w. Bul Am Inst of Min Engrs—April, 1910. No. 13538 F.

Nevada.

Conditions in the Yerington Copper District. John Tyssowski. Map of principal mines of the district with statement of present conditions. 1500 w. Eng & Min Jour—April 9, 1910. No. 13005.

Refining.

The Electrolytic Process of Copper Refining. H. Schroder. Illustrates and describes Australian plants and process used. 2500 w. Aust Min Stand—Feb. 16, 1910. Serial. 1st part. No. 13033 B.

Reverberatory Furnaces.

Smelting Copper in Small Reverberatory Furnaces. Edwin M. Clark. Illustrates and describes a small reverberatory smelting furnace used in Mexico, giving results. 2000 w. Min & Sci Pr—April 23, 1910. No. 13585.

Theoretical Notes on Reverberatory Furnaces. C. A. Grabill. A comparison of results with different fuels. 3500 w. Eng & Min Jour—April 16, 1910. No. 13129.

Slags.

Notes on the Metal Losses in Copper Slags. C. A. Grabill. A study of physical and chemical losses and their causes. 2500 w. Eng & Min Jour—April 9, 1910. No. 13009.

Smelters.

The Granby Smelter Equipment. B. L. Sackett. Illustrates and describes the handling and treatment of the copper ore at this smelter in N. Dakota. 4500 w. Mines & Min—April, 1910. No. 12861 C.

The Washoe Reduction Works in 1909. An account of recent additions and improvements. Ills. 4000 w. Mines & Min —April, 1910. No. 12860 C.

The New International Smeltery at Toole, Utah. John Tyssowski. Illustrated description of the plant designed to smelt the Utah Consolidated and custom ores. 2200 w. Eng & Min Jour—April 23, 1910. No. 13415.

The Steptoe Smelting Plant, Nevada. Leroy A. Palmer. Illustrated detailed description of this plant. 4000 w. Min Wld—April 2, 1910. No. 12879.

The Cerro de Pasco Smelting Works, Peru. Lester W. Strauss. Trans. from *Bol. de la Direc. de Fomento.* Description of the largest installation of the kind in South America. Ills. 3500 w. Min Wld—April 2, 1910. No. 12883.

Washington.

The Northern Cascades. Horace F. Evans. Describes the geology of the Osoyoos basin in the state of Washington and gives the history of the discovery of copper deposits and their development. 1500 w. Min & Sci Pr—March 26, 1910. No. 12804.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Australia.

Some Geological Considerations Affecting Western Australian Ore-Deposits. A Montgomery. Abstract of paper read before the Aust. Inst. of Min. Engrs. Gives a résumé of the geological history and a statement of conclusions and deductions. 3500 w. Min Jour—April 16, 1910. No. 13441 A.

Cyaniding.

Extraction Percentages in Metallurgical Plants. H. A. Megraw. A discussion of the methods of calculating and explanation of a system. 2000 w. Eng & Min Jour—April 2, 1910. No. 12871.

Cyanidation of Silver-Gold Ores at Guanajuato. J. A. Reid. Abstract of paper read before the Min. Soc. of Nova Scotia. An account of the treatment of low-grade silver-gold ores by the cyanide process. 3500 w. Min Wld—April 9, 1910. No. 13022.

Mexico.

Alamos-Promonitos District. Map and description of this region in Mexico, which has yielded precious metals amounting to $100,000,000 in value. 900 w. Min & Sci Pr—April 16, 1910. No. 13291.

Nevada.

Kimberly, Nevada. Jay A. Carpenter. Illustrated description of this mine and its development. 1200 w. Min & Sci Pr—April 2, 1910. No. 12967.

Ontario.

Porcupine Gold Fields Being Actively Exploited. Alex. Gray. Information concerning this district and adjoining territory. 3500 w. Min Wld—April 9, 1910. No. 13021.

Oregon.

The North Pole Mine, Baker County, Oregon. Emil Melzer. An account of an important gold mine worked by tunnels. Section. 1500 w. Eng & Min Jour—April 23, 1910. No. 13416.

Placers.

The Innoko Placer District, Alaska. A. G. Maddern. Abstract from Bul. 240, U. S. Geol. Surv. Sketch map and account of the discovery of placer gold. 2000 w. Min Wld—April 16, 1910. No. 13145.

The Alluvial Gold Fields of Quebec. Alexander Gray. Gives the history of this area, and the present exploitation and development. 2500 w. Min Wld—April 16, 1910. No. 13144.

Quebec.

See Placers, under GOLD AND SILVER.

IRON AND STEEL.

Analysis.

Acid Open-Hearth Slag and Its Analysis. F. C. T. Daniels. Gives a method of analysis for silica, ferrous oxide, manganese oxide, ferric oxide and metallic iron. 2000 w. Ir Trd Rev—March 31, 1910. No. 12809.

Standardization of Permanganate Solutions in the Reinhardt Titration Method (Titerstellung von Kaliumpermanganatlösungen zur Eisentitration nach Reinhardt). Results of an experimental investigation. 2700 w. Stahl u Eisen—March 9, 1910. No. 13357 D.

Australia.

Two Important Iron Ore Deposits of Australia. J. Bowie Wilson. The deposits of Iron Island consists of hematite and magnetite; Koolan Island contains larger bodies. Ills. 1500 w. Eng & Min Jour—April 2, 1910. No. 12876.

Blast-Furnace Gas.

Possible Uses of Waste-Gas Power. I. V. Robinson. Abstract of a paper read before the W. of Scotland Ir. & Steel Inst. Deals only with waste gases from the blast furnace. 3000 w. Ir & Coal Trds Rev—April 8, 1910. No. 13177 A.

The Gas-Cleaning Plant of the Bethlen-Falvahütte in Schwientochlowitz, upper Silesia (Die Gasreinigungsanlage der Bethlen-Falvahütte in Schwientochlowitz, O.-S.). Fr. Berger. Illustrated description. 1800 w. Stahl u Eisen—March 16, 1910. No. 13361 D.

Blast-Furnace Plants.

The New Blast-Furnace at the Gutehoffnungshütte (Die neue Hochofenanlage der Gutehoffnungshütte). Fr. Frölich. Illustrated description. Plates. 1800 w. Stahl u Eisen—March 16, 1910. No. 13360 D.

Blast-Furnace Practice.

The Decomposition of Carbon Monoxide in Presence of Catalytic Agents and in the Blast Furnace. Fritz Zimmermann. Read before the N. Y. section of the Am. Elec. Chem. Soc. Studies and experiments of reactions in the blast furnace. 2500 w. Met & Chem Engng—April, 1910. No. 12798 C.

Calculation of Air Supply for Blast Furnaces (Berechnung der Windmenge für Hochöfen). Discusses and compares the results of three methods, based on the dimensions of the blower, the coke consumption, and the composition of the waste gases. 2500 w. Stahl u Eisen—March 23, 1910. No. 13364 D.

Blast Furnaces.

The New Plant of the Struthers Furnace Co. Illustrated description of the rebuilding and modernizing of a prominent Ohio furnace. 1200 w. Ir Trd Rev—April 14, 1910. No. 13116.

Canada.

Canadian Iron and Steel. Watson Griffin. Reviews the development of this industry. 1500 w. Can Min Jour—April 1, 1910. Serial. 1st part. No. 12949.

Iron and Steel Production in Canada T. Good. A report of recent production and the importance of the industry. 2500 w. Cassier's Mag—April, 1910. No. 13192 B.

China.

The Tayeh Iron Mines. A. J. Seltzer. An account of mines in China, which have been worked since 1888, giving analyses of the ore and limestone, and the raw and finished products of the Hangyeng works. 2500 w. Min Sci Pr—April 16, 1910. No. 13290.

Electrometallurgy.

The Development of Electric Steel Plants (Zur Entwicklung der Elektrostahlanlagen). A list of the electric steel-furnace installations in all parts of the world, with data of capacity, power requirements, products, etc. 2500 w. Stahl u Eisen—March 23, 1910. No. 13363 D.

The Present Status of the Electric Steel Industry. From *Stahl und Eisen*. List of installations, in American and European works, with data as to the system employed, the capacity and character of the product. 1200 w. Ir Age—April 14, 1910. No. 13093.

Electricity in Iron and Steel Manufacture. A. S. Atkinson. Reviews results in Germany, Sweden and Norway, Canada and the United States. 2200 w. Ir Trd Rev—April 28, 1910. No. 13577.

The South Chicago Electric Furnace Plant of the United States Steel Corporation. Illustrated description and information relating to this Bessemer converter, electric furnace combination plant. 3000 w. Met & Chem Engng—April, 1910. No. 12797 C.

The Girod Electric Furnace and Metallurgical Works (Der Girod-Ofen und die elektrischen Schmelzwerke, System Paul Girod). W. Borchers. Describes particularly the Ugine plant. Ills. Serial. 1st part. 1500 w. Oest Zeitschr f Berg- u Hüttenwesen—March 19, 1910. No. 13369 D.

France.

The Briey Iron Ore Deposits in France. Gives the early history of these remarkable deposits, and general information. 1200 w. Ir Age—April 14, 1910. No. 13092.

Deposits of Iron Ore in the French Alps (Die Eisenerzvorkommen in der Fränkischen Alb). E. Holzapfel. A review of their extent and a description of the deposits. Ills. 6000 w. Glückauf—March 12, 1910. No. 13373 D.

Minnesota.

The Minnesota Iron Ranges. G. O. Virtue. Information concerning production, transportation facilities, conditions, labor, mining, wages, cost of living, and related matters. 10500 w. Bul Bureau of Labor—Sept., 1909. No. 13067 N.

Open-Hearth.

An Experimental Investigation of the Hoesch Process (Experimentelle Untersuchungen des Hoechverfahrens). Fr.

Springorum. A report of an extended investigation of the utilization of heat in the process. Ills. 8700 w. Stahl u Eisen—March 9, 1910. No. 13356 D.

See also Analysis, under IRON AND STEEL.

Open-Hearth Furnaces.

Water Cooling Devices for Open Hearth Furnaces. Illustrates and describes a circulating system installed at South Sharon, Pa. 700 w. Ir Age—April 21, 1910. No. 13279.

A New Reversing Valve for Regenerative Furnaces (Neues Umschalteventil für Regenerativfeuerungen). Illustrated description. 1500 w. Giesserei-Zeit—March 1, 1910. No. 13365 D.

Rolling Mills.

The Flattening Effect of Rolling (Das Breiten beim Walzen). Ernst M. Scheld. A discussion of the laws governing lateral extension in rolled material. Ills. 3300 w. Stahl u Eisen—March 9, 1910. No. 13358 D.

A Graphical Method of Investigating the Speed Ratio in Roll Trains (Ein graphisches Verfahren zur Untersuchung der Geschwindigkeitsverhältnisse von Umkehrstrassen). Oskar Rudbach. Describes a method involving the use of continuous indicator diagrams. Ills. 2500 w. Stahl u Eisen—March 23, 1910. No. 13362 D.

LEAD AND ZINC.

Lead Smelting.

Midvale Blast Furnace Practice. Leroy A. Palmer. Illustrates and describes the arrangement and management of lead furnaces. 2000 w. Mines & Min—April, 1910. No. 12866 C.

Smelting Bismuth-Lead Ore, Sinaloa, Mexico. S. E. Bretherton. Describes the ore and method of treatment. 2000 w. Eng & Min Jour—April 9, 1910. No. 13008.

Silver-Lead Smelting in Tasmania. Theodore Kapp. An account of the smeltery erected by the Tasmanian Smelting Co., near Zeehan. 1500 w. Eng & Min Jour—April 2, 1910. No. 12877.

Tasmania.

Notes on the Zeehan Mining Field, Tasmania. Gerard W. Williams. Describes the tin-silver-lead deposits, mining methods, and metallurgical work. 3000 w. Eng & Min Jour—April 2, 1910. No. 12874.

Zinc Smelting.

Treatment of Complex Zinc Sulphide Ores at Oker. Hermann Pape. An account of what has been accomplished in Germany by the Pape-Witter-Babe smelting process. 2500 w. Eng & Min Jour—April 16, 1910. No. 13128.

Charging and Cleaning Machine for Zinc Furnaces. O. Saeger. Illustrated description. 1200 w. Eng & Min Jour—April 9, 1910. No. 13010.

MINOR MINERALS.

Aluminium.

Production of Aluminium as a Laboratory Experiment. B. Neumann and H. Olsen. Refers to process used in practice, and former experiments, and describes the experiments of the authors. 3500 w. Met & Chem Engng—April, 1910. No. 12799 C.

Asphalt.

The Asphalt Industry in Sicily (L'Industria dell' Asfalto in Sicilia). Angelo Coppadoro. The first part discusses the importance of the industry and the composition of the deposits. Ills. Serial. 1st part. 3000 w. Industria—March 6, 1910. No. 13347 D.

Bismuth.

See Lead Smelting, under LEAD AND ZINC.

Diamonds.

The Arkansas Diamond Fields in 1909. John T. Fuller. Brief review of the incorporated companies and their properties. 800 w. Eng & Min Jour—April 9, 1910. No. 13006.

Graphite.

Origin of Certain Adirondack Graphite Deposits. Edson S. Bastin. Deals principally with their characteristics and the conditions under which they have been formed. Ills. 7000 w. Ec-Geol—March, 1910. No. 13493 D.

The Graphite Deposits in Southern Bohemia, with Special Reference to the Schwarzbach, Stuben and Mugrau Mines (Das Graphitvorkommen im südlichen Böhmen mit besonderer Berücksichtigung der Bergbaue Schwarzbach, Stuben und Mugrau). Josef Breitschopf. Ills. Serial. 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—March 12, 1910. No. 13368 D.

Marble.

The Wealth of Georgia's Marble Industry. William H. Stone. An illustrated account of the extensive deposits, the uses made of it, the quarries and finishing works, etc. 6000 w. Mfrs' Rec—April 14, 1910. No. 13080.

Oil.

The Commercial Value of the Oil-Shales of Eastern Canada, Based on Their Contents by Analysis in Crude Oil and Ammonium Sulphate. Dr. R. W. Ells. Read before the Min. Soc. of Nova Scotia. 12500 w. Ind Adv—April, 1910. No. 13617.

The Oil Fields of the Gulf of Mexico. John C. Soley. Chart showing the position and extent, with the history, description of deposits, and discussion of their source and genesis. 2500 w. Sci Am Sup—April 9, 1910. No. 12983.

Platinum.

The Russian Platinum Industry in the Year 1909. E. de Hautpick. A review of the year, discussing causes of reduced production, prices, etc. 4000 w. Min Jour—March 26, 1910. Serial. 1st part. No. 12929 A.

Quicksilver.

Guadalupe Quicksilver Works. Courtenay De Kalb. Reviews briefly the development of this property in California. Ills. 900 w. Min & Sci Pr—March 26, 1910. No. 12803.

Radioactive Minerals.

The Elements of Radium and Radioactivity. L. F. Miller. Deals with the known radioactive elements and their properties; the minerals, the ores with which they are associated, and how to recognize pitchblende. Ills. 2500 w. Min Wld—April 16, 1910. No. 13143.

Tin.

Franklin Mountain Tin Prospects. Regis Chauvenet. An account of location, extent and geology of these deposits near El Paso, Texas, the nature of the ores and development. 3300 w. Mines & Min—April, 1910. No. 12862 C.

Tin Mining in the Federated Malay States. Brief description of methods of mining and treatment. 1800 w. Aust Min Stand—Feb. 16, 1910. No. 13034 B.

The Erzgebirge Tin Deposits. Joseph T. Singewald, Jr. A summary of literature on these deposits, with observations made by the author on a recent trip to the points where mining is still in progress. 3500 w. Ec-Geol—March, 1910. Serial. 1st part. No. 13495 D.

Tungsten.

Notes on Tungsten Minerals from Montana. Alexander N. Winchell. Describes the character and occurrence of the tungsten minerals which have served as ores in Montana. Ills. 2000 w. Ec-Geol—March, 1910. No. 13494 D.

Structure of the Tungsten Deposits of Moose River, N. S. E. R. Faribault. Read before the Min. Soc. of Nova Scotia. A study of the Tungsten-bearing mineral scheelite and its economic importance. 2200 w. Ind Adv—April, 1910. No. 13616.

MINING.

Assay Plans.

See Records, under MINING.

Boring.

A Deep Boring at Heswell, Cheshire. An account of explorations for concealed coal measures. 3500 w. Ir & Coal Trds Rev—April 8, 1910. No. 13175 A.

See also Prospecting, under MINING.

Bunk Houses.

Housing Conditions at the Garfield Smelter. L. S. Austin. Illustration, and brief account of the arrangements for housing laborers of different nationalities. 1200 w. Min & Sci Pr—April 23, 1910. No. 13584.

Drainage.

Mine Drainage in Joplin District. Lucius L. Wittich. Method by which large amounts of water are handled are illustrated and described. 3200 w. Mines & Min—April, 1910. No. 12864 C.

Electric Haulage.

Description of Electric-Haulage Plant in Operation in No. 5 Colliery, Sydney Mines, Nova Scotia. Robert Robertson. Read before the Min. Soc. of Nova Scotia. 3300 w. Ind Adv—April, 1910. No. 13618.

Electric Hoisting.

Electric Mine Hoists. D. B. Rushmore and K. A. Pauly. A detailed discussion of the advantages of the electric system. 6500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13229 F.

The Electric Hoist at the Heinitz Mines, Beuthen, Upper Silesia (Die elektrische Fördermaschine der kons. Heinitzgrube in Beuthen, O.-S.). Herr v. Groddeck. Illustrated description. 2500 w. Glückauf—March 12, 1910. No. 13374 D.

Electric Power.

See Switch Gear, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosives.

Underground Magazine at the Hohenthal Mine, Helbra, Germany (Das unterirdische Sprengstofflager des Hohenthalschachtes bei Helbra). Dr. Heinhold. Illustrated description. 1300 w. Glückauf —March 26, 1910. No. 13377 D.

Haulage.

Ore Handling Plants in the Lorraine-Luxemburg Minette District, Especially the Haulage Plant of the Düdelingen Ironworks (Massenförderanlagen im lothringisch-luxemburgischen Minettebebiet, insbesondere die Seilförderungen des Eisenhütten - Aktien - Vereines Düdelingen). Fr. Tillmann. Illustrated description. 5000 w. Zeitschr d Ver Deutscher Ing—March 12, 1910. No. 13511 D.

Hoisting Engines.

See Valve Setting, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Law.

Growth of American and Australian Mining Law. A. C. Veatch. Compares the laws of America and Australia, explaining the causes that helped to form them. 9500 w. Eng & Min Jour—April 2, 1910. No. 12875.

Mine Waters.

See Sterilization, under CIVIL ENGINEERING, WATER SUPPLY.

Prospecting.

Copper Prospecting with Churn Drills in Arizona. William G. Weber. An account of the work. Ills. 3000 w. Wis Engr—April, 1910. No. 13201 D.

Quarrying.

The Ashokan Reservoir Stone Quarry. Describes methods of work at the Yale quarry, where stone is prepared for this great engineering work. 2200 w. Eng Rec—April 2, 1910. No. 12830.

Records.

Mount-Morgan Mine Records and Assay Plans. J. Bowie Wilson. An explanation of the assay plans and their value, the records, etc. 3000 w. Eng & Min Jour—April 2, 1910. No. 12873.

Shaft Sinking.

Sinking by Means of Underhanging Tubbing. Describes plant and method used at Hamsterley Colliery, England. 1000 w. Eng & Min Jour—April 23, 1910. No. 13417.

Filbert Mine Concrete-Lined Shafts. A. F. Allard and Herbert S. Patterson. Methods and materials used, and machinery employed in sinking and lining this shaft in Fayette County, Pa. Ills. 8500 w. Mines & Min—April, 1910. No. 12868 C.

Stoping.

Method of Square Set Stoping at Bisbee. Morris J. Elsing. Describes this method which is used almost exclusively at Bisbee, Ariz., and gives details of timbering. 2300 w. Eng & Min Jour—April 2, 1910. No. 12872.

Surveying.

Measurements in Leased Properties (Kontrollvermessungen in verliehenen Grubenmassen). Viktor Kadainka. Discusses methods of determining underground boundaries. Ills. Serial. 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—March 5, 1910. No. 13367 D.

Timbering.

See Stoping, under MINING.

Track Switches.

Novel Automatic Switch. C. S. Beach. Describes a device by which loaded and empty cars are automatically switched alternately. 1500 w. Mines & Min—April, 1910. No. 12869 C.

Valuation.

Examining and Sizing-Up Mine Prospects. Arthur Lakes. Suggestions helpful in forming a correct estimate of prospects. 2500 w. Min Wld—April 23, 1910. No. 13435.

ORE DRESSING AND CONCENTRATION.

Diaphragm Cones.

Diaphragm Cones and Tube Milling. Walter Neal. Brief illustrated description of the apparatus as used in the mills of the Cia. Minera Las Dos Estrellas, and some experiments made with it as a thickener before tube-milling. 1200 w. Min & Sci Pr—April 2, 1910. No. 12968.

Gold Milling.

Tonopah Extension Mill. John G. Kirchen. A brief description of the machinery and arrangement of the plant. 2000 w. Min & Sci Pr—April 9, 1910. No. 13120.

Lead Milling.

Wet Concentration at Midvale, Utah. Leroy Palmer. Describes the concentrator and methods of saving the lead contents of the ore, and also the lead-iron-zinc concentrate. 3500 w. Mines & Min—April, 1910. No. 12859 C.

MISCELLANY.

Analyses.

Sources of Error in Analyses. R. C. Banner. Discusses incorrect calibration of weights and volumetric apparatus. 1500 w. Min & Sci Pr—April 2, 1910. No. 12970.

Australia.

The Queensland Mining Industry. Report of the under-secretary for mines, reviewing the industry for the year 1909. 22500 w. Queens Gov Min Jour—March, 1910. No. 13036 B.

Chemical Industries.

The Chemical Industries of America. Charles E. Munroe. Address at meeting of the Am. Inst. of Chem. Engrs., Phila. Gives a sketch, based on the best statistical data, of the chemical industries of the United States, their present extent and future possibilities. 2500 w. Met & Chem Engng—April, 1910. Serial. 1st part. No. 12802 C.

Congo.

Mining-Conditions in the Belgian Congo (Congo Free State). Sydney H. Ball and Millard K. Shaler. Information concerning conditions, topography, geology, prospecting, mining, and products in this part of Africa. Maps & Ills. 800 w. Bul Am Inst of Min Engrs—April, 1910. No. 13537 F.

Mineralogy.

Determination of Common Ores and Minerals. J. P. Rowe. Gives a few physical tests for determining with some accuracy the more common ores and minerals. 3500 w. Min Wld—April 2, 1910. No. 12880.

Ore Deposits.

Geology Applied to Mining. T. A. Rickard. The Le Neve Foster Memorial Lecture, delivered at the Royal School of Mines, London, on March 4, 1910. Reviews the early history of geological study and the study of ore deposits, and summarizes the conclusions now accepted. 3000 w. Min & Sci Pr—April 2, 1910. Serial. 1st part. No. 12966.

Some Causes of Ore Shoots. R. A. F. Penrose, Jr. Defines the term and considers the influences which act singly or together in producing them. Ills. 10800 w. Ec-Geol—March, 1910. No. 13492 D.

Relation of Mineral and Chemical Industries. George T. Holloway. Abstracted from *Jour. of the Soc. of Chem. Ind.* A study of the formation of typical minerals from their igneous source to the forms familiar to mineralogists. 4000 w. Min Wld—April 9, 1910. Serial. 1st part. No. 13020.

Petrography.

Coloration of Clays by Aniline Coloring Matters (Coloration des Argiles par les Couleurs d'Aniline). M. F. Grandjean. A discussion of the utilization of the absorption properties of clays in petrographic researches. 3000 w. Rev de Métal—March, 1910. No. 13317 E + F.

Refractory Materials.

The Thermal Conductivity of Fire Clay at High Temperatures. Gives results of experiments to determine heat losses in furnace walls and similar work. Ills. 2500 w. Ir Trd Rev—April 28, 1910. No. 13576.

Tropical Countries.

Mining in Tropical Climates. John Power Hutchins. Suggestions for overcoming the difficulties and for prevention of sickness. Ills. 5300 w. Mines & Min—April, 1910. No. 12858 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Railway Signalling. V. I. Smart. Outlines the development of the present system of train operation by Standard Code, comparing with train operation in Europe, and commences a discussion of methods that will give greatest safety, expedition in movement, and lowest possible cost consistent with these. 3500 w. Can Engr—April 22, 1910. Serial. 1st part. No. 13437.

Report on the Question of Operation of Switches and Signals (Subject X for Discussion at the Eighth Session of the Railway Congress). Prof. Dr. Ulbricht. A review of progress in Continental countries. 18500 w. Bul Int Ry Cong—Jan., 1910. No. 13602 G.

Report on the Question of Operation of Switches and Signals (Subject X for Discussion at the Eighth Session of the Railway Congress). E. C. Carter. A review of conditions existing in America. Ills. 4400 w. Bul Int Ry Cong—March, 1910. No. 13484 G.

How to Be a Good Maintainer. William Rife. Considers the essentials of successful maintenance of mechanical interlocking. 2000 w. Sig Engr—April, 1910. No. 13203.

The Chemistry of the Gravity Battery. With special reference to its installation and maintenance in railway signaling. 2000 w. Sig Engr—April, 1910. No. 13202.

Train Acceleration.

An Instrument for Measuring Acceleration and Gradient. Ilustrated description of the Wimperis accelerometer, explaining its applications. 800 w. Eng News—April 28, 1910. No. 13573.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

I. Triple Valve Test Rack. II. Triple Valve Tests. Illustrates and describes this test rack, and remarks on triple valve tests. 1500 w. Ry & Loc Engng—April, 1910. No. 12795 C.

Baggage Cars.

Cars for Handling Baggage Trucks, Hudson Tunnel Lines. Illustrated description of an all-steel car for transporting loaded trucks to eliminate extra handling. 1000 w. Ry & Engng Rev—April 9, 1910. No. 13031.

Car Disinfection.

The Disinfecting of Passenger Coaches. P. Schumacher. From *Ann. fur Gewerbe und Bauwesen.* Illustrated description of the apparatus, its operation, and results. 2500 w. Ry Age Gaz—April 1, 1910. No. 12889.

Car Ventilation.

Ventilation of Cars. Brief illustrated description of the method devised by T. H. Garland. 700 w. Ry & Loc Engng—April, 1910. No. 12791 C.

Electrification.

Report of Committee on Electrification. Report and general discussion, with illustrations. 22000 w. Pro N Y R R Club—March 18, 1910. No. 13197.

Electrification of the Bavarian State Railways. J. Jacquin. A review of a recent report. 8600 w. Bul Int Ry Cong—Jan., 1910. No. 13605 G.

Electric Traction on the Mersey, the Midland, and the North Eastern Railway. Papers by Shaw, Dalziel & Sayers, and Harrison discussed together. Ills. 60000 w. Inst of Civ Engrs—Nov. 9, 1909. Papers 3794, 3847 and 3863. No. 13271 N.

Freight Cars.

Steel in Freight Car Construction. C. A. Seley. An illustrated article describing an improved design of structural steel freight cars, where the value of the superstructure as a truss has been considered as an element of strength. 2500 w. Jour Fr Inst—April, 1910. No. 13534 D.

Steel Car Construction. C. R. Harris. Read before the New England Ry. Club. Discusses the relative merits of structural steel and pressed steel, favoring the former. Ills. 6000 w. Ry Mas Mech—April, 1910. No. 13066.

See also Locomotive Designs, under MOTIVE POWER AND EQUIPMENT.

Lighting Cars.

A Motor Lighting Car (Voiture automobile d'Eclairage). G. Zindel. Describes a European car equipped with generating machinery to supply light for night work, tunnel examinations, etc. Ills. 1800 w. Bul Tech d l Suisse Romande—March 25, 1910. No. 13328 D.

Locomotive Boilers.

Report on the Question of Improvements in Locomotive Boilers (Subject VI, Littera A and B, for Discussion at the Eighth Session of the Railway Congress). H. H. Vaughan. Considers boilers with smoke tubes, and boilers with water tubes, superheaters, and feed water heaters in America. Ills. 26500 w. Bul Int Ry Cong—Feb., 1910. No. 13608 G.

On the Question of Improvements in Locomotive Boilers (Subject VI, Littera B, for Discussion at the Eighth Session of the Railway Congress). Franz Gerstner. Report for Austria-Hungary, Rumania, Bulgaria, Servia and Turkey on boilers with water tubes, steam superheaters and valve gear for superheated steam and feed-water heaters. Ills. 9800 w. Bul Int Ry Cong—March, 1910. No. 13479 G.

Improvements in Locomotive Boilers in Belgium, Spain, France, Italy and Portugal (Perfectionnements des Chaudières de Locomotives en Belgique, Espagne, France, Italie et Portugal). M. Nadal. A general review. 12000 w. All Indus—March, 1910. No. 13329.

Locomotive Construction.

Economy of Removable Driving Box Brasses. W. J. Shadle. Drawings and explanation of successful devices. 1000 w. Am Mach—Vol. 33. No. 17. No. 13554.

Report on the Question of the Use of Steel (Subject V, Littera A, for Discussion at the Eighth Session of the Railway Congress). D. F. Crawford. The use of steel in the construction of rolling stock in America is discussed. Ills. 15500 w. Bul Int Ry Cong—Feb., 1910. No. 13607 G.

The Use of Steel in Locomotive and Car Construction. Extracts from a report by D. F. Crawford for discussion at the International Railway Congress. Aims to give results obtained in America from a general operating and maintenance standpoint. 4500 w. Ry Age Gaz—April 1, 1910. No. 12888.

See also Alloy Steels, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Locomotive Fuels.

Wheeling & Lake Erie Coal Tests. A report of tests made to determine economy of different grades. 2000 w. Ry Age Gaz—April 22, 1910. No. 13410.

Fuel Tests on the Wheeling & Lake Erie R. R. A digest of a report of these tests made by B. A. Worthington; and instructions for fuel tests by J. E. Muhlfeld. 2500 w. Ry & Engng Rev—April 9, 1910. No. 13030.

Locomotive Literature.

The Books of the Locomotive. Lawford H. Fry. A review of important books on the locomotive, covering English, French, German and American practice. 3500 w. Engr, Lond—March 25, 1910. Serial. 1st part. No. 12940 A.

Locomotive Operation.

Coal and the Locomotive. George S. Hodgins. Aims to trace the action of the stored power in coal until it produces motion in the modern locomotive. 2500 w. Ap Sci—March, 1910. No. 13213 C.

Locomotive Power.

Tractive Power Analyzed. George S. Hodgins. Diagrams and analysis. 1200 w. Ry & Loc Engng—April, 1910. No. 12788 C.

Locomotives.

Report on the Question of Steam Locomotives for Very High Speed (Subject VII for Discussion at the Eighth Session of the Railway Congress). William Garstang. Considers steam locomotives for obtaining regulation speeds exceeding 60 miles per hour in America. Ills. 7700 w. Bul Int Ry Cong—Feb., 1910. No. 13609 G.

Tank Engines for Fast Passenger Traffic. Illustrates and describes the principal features of recent designs, and gives information concerning the work done by them on British railways. Plate. 1200 w. Engr, Lond—April 1, 1910. No. 13060 A.

The First Application of the Mallet System to High-Speed Locomotives (La première Application du Système Mallet aux Locomotives à grande Vitesse). Henry Martin. Describes and discusses the new Santa Fe locomotive. Ills. 2500 w. Génie Civil—March 12, 1910. No. 13336 D.

The Mallet Compound Locomotive and Its Limitations. Editorial discussing its present unfitness for fast service. 700 w. Ry Age Gaz—April 22, 1910. No. 13405.

Mallet Pusher Locomotive: Canadian Pacific Railway. Describes the special features of an engine built for operation on heavy grades and used as a pusher. 1500 w. Eng News—April 7, 1910. No. 13002.

An Experimental Mallet Articulated Locomotive. Illustrated detailed description of an engine designed and constructed for the Canadian Pacific Ry., calling attention to its novel features. 3000 w. Mech Engr—March 25, 1910. No. 12930 A.

Mallet Articulated for the B. & A. Illustration and description of a new engine for hauling freight on steep grades. 1200 w. Ry & Loc Engng—April, 1910. No. 12793 C.

Mallet Articulated Compound Locomotive, 2-6-6-2 Type. Illustrated description of a locomotive with large boiler capacity built for freight service on the Boston & Albany R. R. 1000 w. Am Engr & R R Jour—April, 1910. No. 13024 C.

Mallet Locomotives for the Southern Pacific. Illustrated description. 500 w. Ry Age Gaz—April 22, 1910. No. 13408.

Mallet Articulated Compound Locomotive. New York Central Lines. Illustrated description of a new locomotive for the Boston & Albany division. 1200 w. Ry Age Gaz—April 1, 1910. No. 12887.

New Locomotives for the St. Louis & San Francisco R. R. Co. Illustrates and describes the Pacific type for passenger service, and the consolidation type for heavy freight service. 1200 w. Ry & Engng Rev—April 16, 1910. No. 13146.

Baldwin Mallet for the Galveston, Harrisburg & San Antonio Ry. Illustration with description of recently built engines. 800 w. Ry & Loc Engng—April, 1910. No. 12789 C.

Eight-Coupled Locomotives; Natal Government Railways. Illustrations, with description of 14-wheeled locomotives for 3 ft. 6 in. gauge. 700 w. Engng—April 1, 1910. No. 13056 A.

Six-Coupled Locomotive for the Tientsin-Pukow Railway, China. Illustrated description of an American-built engine. 400 w. Engng—April 15, 1910. No. 13463 A.

Motor Cars.

Report on the Question of Motor Vehicles (Subject XII for Discussion at the Eighth Session of the Railway Congress). L. Greppi. The use and cost of motor vehicles or self-moving cars, in all countries except Great Britain and America. Ills. 19000 w. Bul Int Ry Cong—March, 1910. No. 13483 G.

Inspection and Repair of Motor Cars. W. B. Kouwenhoven. Describes the methods of inspection to determine repairs needed. 2000 w. Ry & Loc Engng—April, 1910. No. 12796 C.

Passenger Cars.

New Private Car for the Queen of England. C. Van Langendonck. Illustrated detailed description. 1000 w. Ry Age Gaz—April 15, 1910. No. 13125.

See also Locomotive Design, under Motive Power and Equipment.

Shops.

Readville Locomotive Shop—New York, New Haven and Hartford Railroad. Illustrated description of the arrangement and construction of the buildings, grouping and location of the machine tools and methods of operation of the shops. 4500 w. Am Engr & R R Jour—April, 1910. No. 13023 C.

Car Wheel Foundry and Practice, Chicago, Milwaukee & St. Paul Railway. George L. Fowler. Illustrated detailed description of the foundry, the manufacturing methods and tests. 5000 w. Ry Age Gaz—April 1, 1910. No. 12890.

Locomotive and Car Shops of the Isthmian Canal Commission. Extract from the annual report of the Isthmian Canal Commission giving data on the motive power department of the Panama R. R. Ills. 2500 w. Ry Mas Mech—April, 1910. No. 13065.

Convenient Pickling Vat. Illustrated description of a new arrangement in the equipment of the St. Louis & San Francisco R. R. shops at Springfield, Mo. 900 w. Ry & Loc Engng—April, 1910. No. 12790 C.

Sleeping Cars.

New Steel Pullman Sleeping Car. Illustrated description. 500 w. Ry Age Gaz—April 29, 1910. No. 13597.

New Sleeping Cars for the Illinois Traction System. Illustrated detailed description of sleeping cars for an interurban road. 2000 w. Ry & Engng Rev—April 23, 1910. No. 13436.

Train Ferries.

See Ferry Steamers, under MARINE AND NAVAL ENGINEERING.

Train Lighting.

Electric Car Lighting. J. R. Sloan. Presents the advantages of electric lighting, the systems that have been followed and the difficulties of each. General discussion. 8000 w. Pro Cent Ry Club—March 11, 1910. No. 13532 C.

NEW PROJECTS.

Arabia.

The Hedschas Railway (Die mohammedanische Eisenbahn, Hedschasbahn). E. A. Ziffer. A brief general description of the project. Ills. 5000 w. Zeitschr d Oest Ing u Arch Ver—March 4, 1910. No. 13397 D.

Switzerland.

New Swiss Railway Projects (Neue schweizerische Eisenbahnprojekte). R. Moser. A brief review of proposed lines. Ills. 3000 w. Schweiz Bau—March 26, 1910. No. 13381 B.

Trinidad.

Railway Extensions in Trinidad. Information concerning proposed extensions of great importance to the island. 700 w. Ry Age Gaz—April 1, 1910. No. 12885.

PERMANENT WAY AND BUILDINGS.

Construction.

Rocklin-Colfax Second Track Construction, Southern Pacific Co. Illustrated description of construction work through a broken country, requiring 17 tunnels of various lengths in about 36 miles. 1500 w. Ry & Engng Rev—April 2, 1910. No. 12907.

Elevated Railways.

Track Elevation on the Chicago, Milwaukee & St. Paul at Evanston, Ill. Illustrated description of work of interest because of artistic design and the methods of handling traffic while the work was in progress. 2000 w. Ry Age Gaz—April 8, 1910. No. 12976.

Stations.

Report on the Question of Large Stations (Subject IX for Discussion at the Eighth Session of the Railway Congress). Mr. Julien and Mr. Leverve. Considers best arrangement of tracks, improved appliances, etc., for all countries except America, Russia, Austria-Hungary, Rumania, Bulgaria, Servia and Turkey. Ills. 7000 w. Bul Int Ry Cong—Feb., 1910. No. 13614 G.

Switches.

See Track Construction, under PERMANENT WAY AND BUILDINGS.

Terminals.

Grand Central Improvement Work. Illustration and information relating to the new station of the N. Y. C. & H. R. R. R. 700 w. Ry & Loc Engng—April, 1910. No. 12792 C.

New Locomotive Terminal of the Vandalia at Terre Haute, Ind. Illustrates and describes the general arrangement and details of the principal structures. 1200 w. Ry Age Gaz—April 22, 1910. No. 13409.

Ties.

The Supply and Employment of Beech Railway Ties (Die Beschaffung und Verwendung buchener Eisenbahnschwellen). Herr Schneidt. Discusses the use of beech railway ties in Germany. Ills. 11000 w. Glasers Ann—March 1, 1910. No. 13394 D.

Track Construction.

Report on the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). F. Tettelin and M. Cossmann. Considers arrangements of the road appliances for passing at high speed over switches and swing-bridges in France, Italy, Spain and Portugal. Ills. 10900 w. Bul Int Ry Cong—Feb., 1910. No. 13611 G.

Report on the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). L. Motte. Considers the arrangement of road appliances for passing at high speed over switches and swing bridges, in all countries except France, Italy, Spain, Portugal, Great Britain and America. Ills. 8000 w. Bul Int Ry Cong—March, 1910. No. 13482 G.

On the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). W. G. Besler. Report for America in regard to arrangement of road appliances for passing at high speed over switches and swing bridges. Ills. 5000 w. Bul Int Ry Cong—March, 1910. No. 13478 G.

Track Maintenance.

Railway Maintenance of Way. W. H. Hoyt. Suggestions for the maintenance of a first class roadbed. Ills. 3500 w. Minn Engr—March, 1910. No. 13075 C.

Tunnels.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). Mr. Canat. Considers tunnels in mountainous countries (the Alps excepted) and great town tunnels (Great Britain excepted). Ills. 30000 w. Bul Int Ry Cong—Feb., 1910. No. 13613 G.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). Felix Sartiaux. Considers methods used for submarine tunnels. Ills. 7300 w. Bul Int Ry Cong—Feb., 1910. No. 13610 G.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). F. Hennings. Illustrated description of the Alpine tunnels. 15200 w. Bul Int Ry Cong—Feb., 1910. No. 13615 G.

Yards.

Freight Yard Construction. Claude L. Van Auken. A general account of the work, with special reference to a yard near Chicago. 2800 w. Wis Engr—April, 1910. No. 13199 D.

The Long Island Improvements of the Pennsylvania System. Map and illustrated description of the Sunnyside yard on Long Island, with editorial note. 4000 w. Eng Rec—April 16, 1910. No. 13138.

Western Pacific Yards and Terminals. Gustave E. Lemmerich. Illustrates and describes interesting details. 1500 w. Ry Age Gaz—April 22, 1910. No. 13407.

The New Wustermark Shunting Yard. Description. 1500 w. Bul Int Ry Cong—Jan., 1910. No. 13606 G.

TRAFFIC.

Car Interchange.

Note on the Utility of Studying the Question of Freight Car Interchange and Demurrage. W. F. Allen. A discussion of car service problems. 80000 w. Bul Int Ry Cong—Jan., 1910. No. 13600 G.

Freight.

Report on the Question of Transhipment (Subject XX for Discussion at the Eighth Session of the Railway Congress). C. de Burlet. Examination of the different systems adopted for the exchange of goods between lines of different gauges. Ills. 9000 w. Bul Int Ry Cong—Jan., 1910. No. 13604 G.

The Transit Privilege: Abuses of It and Some Proposed Remedies. S. O. Dunn. Explains the uses of the transit privilege, its misuses, and suggests plans for improving present conditions. 5000 w. Ry Age Gaz—April 29, 1910. No. 13596.

A Remarkable Record in Low Cost Freight Haulage on a Railway of Heavy Traffic. Editorial on the operating records of the Bessemer & L. Erie R. R., its heavy traffic and the low cost of handling freight. 1200 w. Eng News—April 21, 1910. No. 13262.

Freight Rates.

What Is the Rate Making Power of the Interstate Commerce Commission? A critical discussion of the authority of the commission. 2000 w. Ry Age Gaz—April 29, 1910. No. 13595.

Which Line Makes the Rate? William

Z. Ripley. An examination of this question, with the conclusion that everything depends on local circumstances and conditions. 2500 w. Ry Age Gaz—April 1, 1910. No. 12884.

Pullman Rates.

Pullman Car Changes Found unreasonable. Reprint of the decision of the Interstate Commerce Commission in the Pullman case with editorial discussion. 2500 w. Ry Age Gaz—April 15, 1910. No. 13124.

Waterway Competition.

Report on the Question of Railways and Waterways (Subject XIII for Discussion at the Eighth Session of the Railway Congress). William E. Hoyt. An investigation of the influence of waterways considered as feeders and as competitors, in America. 3900 w. Bul Int Ry Cong—Feb., 1910. No. 13612 G.

Report on the Question of Railways and Waterways (Subject XIII for Discussion at the Eighth Session of the Railway Congress). C. Colson and Louis Marlio. Investigates the influence of waterways considered as feeders and as competitors of railways in all countries except Great Britain and America. Ills. 4600 w. Bul Int Ry Cong—March, 1910. No. 13481 G.

MISCELLANY.

Accounting.

Railway Depreciation Accounts. C. J. Sturgis. Address before the Nat. Assn. of Ry. Com. Considers depreciation accounts in relation to the question of railway regulation. 4000 w. Ry Age Gaz—April 8, 1910. No. 12975.

See also Statistics, under MISCELLANY.

Belgium.

The Light Railways of Belgium. Lionel Wiener. Illustrates and describes local transportation developments. 2500 w. Cassier's Mag—April, 1910. No. 13194 B.

England.

The Enfield and Stevenage New Loop Line. Map and description of a new line for the Great Northern (England), 5 miles in length. Bridges and viaducts are illustrated. 1700 w. Engr, Lond—April 1, 1910. No. 13061 A.

Madagascar.

The Brickaville-Tananarive Railway (Note sur le Chemin de Fer de Brickaville à Tananarive). M. R. Godfernaux. Describes the construction of this railway in Madagascar. Ills. 13000 w. Rev Gen d Chemins de Fer—March, 1910. No. 13322 G.

Management.

The Fundamental Principles of Efficiency. Harrington Emerson. A discussion of efficiency in railroad operation. General discussion. 17500 w. Pro Ry Club of Pittsburgh—Feb. 25, 1910. No. 13196 C.

Natal.

The Natal Government Railways and the Policy of Improvement. Editorial discussion of conditions in South Africa and the problems that affect the railways. 2500 w. Engng—April 15, 1910. No. 13464 A.

Statistics.

Report on the Question of Statistics (Subject XIV for Discussion at the Eighth Session of the Railway Congress). W. M. Acworth. Considers principles of statistics of railways in operation, and the uniform classification of working expenses. 4000 w. Bul Int Ry Cong—Jan., 1910. No. 13599 G.

United States.

The Railways' Cost of Living. Frederick E. Voegelin. Reviews the accounts for 1907, comparing with 1897, as reported by the Interstate Commerce Commission. 2500 w. Ry Age Gaz—April 15, 1910. No. 13123.

STREET AND ELECTRIC RAILWAYS.

Brakes.

Electric Braking on Glasgow Corporation Tramcars. A. Gerrard. Abstract of a paper read before the Inst. of Elec. Engrs. Information concerning the Newell brake of old and recent types, reporting tests. Also refers to an automatic sanding apparatus. 5500 w. Elec Engr, Lond—April 8, 1910. No. 13152 A.

Canal Haulage.

Gantry-Frame Two-Side Towing Locomotive for Lock Haulage, Bremen, Germany. Illustration, with brief description, of the "electric mule" for boat haulage at locks of Weser River dam, Bremen, Germany. 400 w. Eng News—April 21, 1910. No. 13261.

Car Barns.

Construction of New Buildings, Improvement of Existing Structures, Fire Protection and Insurance—Metropolitan Street Railway. Illustrated description of recent improvements in New York City. 5500 w. Elec Ry Jour—April 16, 1910. No. 13118.

Car Inspection.

Inspection of Car Equipment on Electric Railways. M. B. Lambert. Gives an outline of a system of value in maintaining cars so that there will be few interruptions of service. 2500 w. Elec Jour—April, 1910. No. 13211.

Inspection and Repair of Electrical Equipment. Describes electrical practices of a company whose methods are thorough and give satisfactory results. Ills. 1600 w. Elec Ry Jour—April 2, 1910. No. 12822.

Car Maintenance.

See Shops, under STREET AND ELECTRIC RAILWAYS.

Cars.

Value of Lightness in Cars. M. V. Ayres. Considers the saving in operating expenses and the results of reducing the weights of cars. 2000 w. Elec Ry Jour—April 16, 1910. No. 13119.

Storage Battery and Gasoline-Electric Cars on the Third Avenue Railroad. Illustrates and describes the new storage-battery cars on trial, and gives data on the operation of the storage-battery, and gasoline-electric cars. 1200 w. Elec Ry Jour—April 23, 1910. No. 13297.

Reduced Weight Semi-Convertible Car. Illustrated description of an interesting design built for the Boston & Northern and the Old Colony street railways. 3500 w. Elec Ry Jour—April 2, 1910. No. 12821.

Car Ventilation.

Types of Street Car Ventilating Systems. The Cooke system, and the Peter Smith car ventilator are illustrated and described. 1200 w. Heat & Vent Mag—April, 1910. No. 13544.

Electric Traction.

Electric Traction on the Continent. A. J. Thompson. Illustrates and describes special installations on main line railways in Switzerland, Germany, and other parts of the Continent. 5000 w. Cassier's Mag—April, 1910. No. 13191 B.

Report on the Question of Electric Traction (Subject VIII for Discussion of the Eighth Session of the Railway Congress). George Gibbs. Deals with electric traction on large railroads in America, discussing continuous and alternating current and the comparative cost. Ills. 13500 w. Bul Int Ry Cong—Jan., 1910. No. 13601 G.

On the Question of Electric Traction (Subject VIII for Discussion at the Eighth Session of the Railway Congress). Dr. Gleichman. A discussion of electric traction on large railroads in Germany, continuous and alternating current and the comparative cost. Ills. 17400 w. Bul Int Ry Cong—March, 1910. No. 13480 G.

Interurban.

The 1200-Volt Railroad—A Study of Its Value for Interurban Railways. Charles E. Eveleth. Compares the 1200-volt and 600-volt direct-current systems in the interurban field, claiming economical advantages for the former. General discussion. 5000 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13237 F.

Locomotives.

Centre of Gravity and Oscillations in Electric Locomotives (Schwerpunktlage und Kreiselwirkungen bei elektrischen Lokomotiven). G. Brecht. A discussion of the influence of the position of the centre of gravity. Ills. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—March 4, 1910. No. 13506 D.

Electric Locomotive for the N. Y., N. H. & H. Railroad. Illustrates and describes an engine designed primarily for handling fast freight, but will also be used for fast passenger service. 1200 w. Ry & Loc Engng—April, 1910. No. 12794 C.

Lyons, France.

The Street Railway System of the City of Lyons, France. Alfred Gradenwitz. Illustrated description of a line recently converted to the single-phase system. 1500 w. Elec Rev, N Y—April 30, 1910. No. 13619.

Monorail.

The Technical and Economic Possibilities of Monorailways (Die technischen und wirtschaftlichen Aussichten der einschienigen Kreiselbahn). Herr Schimpff. A discussion of their engineering features. 4000 w. Elek Kraft u Bahnen—March 4, 1910. No. 13507 D.

The Brennan and Scherl Monorail Cars (Automotrices Monorails à Gyroscopes Systèmes Brennan et Scherl). Ch. Dantin. A description and comparison of the systems. Ills. 2500 w. Génie Civil—March 26, 1910. No. 13341 D.

Motor Maintenance.

Recent Practice in Motor Maintenance in Boston. Illustrates and describes special appliances of a labor-saving character. 3000 w. Elec Ry Jour—April 9. 1910. No. 12973.

Municipal Ownership.

The Financial Position of Tramway Undertakings, Owned and Worked by Municipal Corporations, as Indicated by the Tramway and Light Railways Return of the Board of Trade for 1908-1909. 4500 w. Tram & Ry Wld—March 10, 1910. No. 12721 B.

Operating Costs.

Cost of Operating the Manhattan Elevated Railways. Gives itemized costs of operating the Manhattan Elevated in New York City for the year ending June 30. 1908. 1200 w. Engng-Con—April 20. 1910. No. 13404.

Cost of Constructing and Operating the Electric Street Railways of Long Island City—The New York and Queens County Railway. Gives data relating to the year ending June 30, 1908. 1500 w. Engng-Con—April 27, 1910. No. 13557.

Rack Railways.

The Salève Electric Rack Railway (Notice sur le Chemin de Fer électrique à Crémaillère du Salève). M. Vagneux. Brief description of an installation near Geneva. 2000 w. Ann d Ponts et Chaussées—1910-I. No. 13311 E + F.

Shops.

Interesting Shop Practices at Indianapolis. Describes methods of caring for wheels, brakes and motors on a large road. Ills. 3500 w. Elec Ry Jour—April 2, 1910. No. 12824.

Shops of the Cincinnati Traction Company. Illustrates and describes the motor-driven tools, the armature shop methods, and the system of card records used. 4500 w. Elec Ry Jour—April 2, 1910. No. 12823.

Shops of the London Underground Electric Railways. Illustrates and describes interesting features of the tube shops. 1500 w. Elec Ry Jour—May 7, 1910. No. 13766.

Department of Rolling Stock and Shops of the Metropolitan Street Railway, New York. An illustrated account of important improvements made in this department since the appointment of receivers. 6000 w. Elec Ry Jour—April 2, 1910. No. 12820 C.

Improvements in the Department of Rolling Stock and Shops of the Metropolitan Street Railway. Describes detailed improvements in methods and machinery. Ills. 2500 w. Elec Ry Jour—April 9, 1910. No. 12974.

The Interborough Repair Shops. W. B. Kouwenhoven. Explains methods of inspection and repair in uses at these shops. 2000 w. Ry & Loc Engng—May, 1910. No. 13640 C.

Signals.

Automatic Signals for Electric Railways. Carl P. Nachod. A brief illustrated review of electric railway signalling with a description of a particular type of contact system. 3000 w. Jour Fr Inst—April, 1910. No. 13535 D.

Snow Removal.

Snow Fighting Methods and Organization of the Metropolitan Street Railway Co. An explanation of the organization and methods in force in New York City. 3000 w. Elec Ry Jour—April 23, 1910. No. 13296.

Subways.

Cost of the New York Subway and of Operating It. Considers the first cost, cost of equipment, and cost of operation. 2000 w. Engng-Con—April 13, 1910. No. 13001.

Traffic Conditions Influencing Passenger Subway Construction in Chicago, Ill. Outlines traffic conditions, and the plans that have been proposed for constructing subways. Diagrams. 1500 w. Engng-Con—April 20, 1910. Serial. 1st part. No. 13403.

Maintenance and Operating Features of the Electrified St. Clair Tunnel. An illustrated account of the performance of this line. 7500 w. Elec Ry Jour—April 2, 1910. No. 12825.

Electric Traction Development. An account of the Sydney harbor subway scheme, with map. 3500 w. Aust Min Stand—March 16, 1910. No. 13488 B.

Subway Ventilation.

The Ventilation of the New York and Paris Subways (Ventilation des Métropolitains de New York et de Paris). H. Deniau. A review and comparison of the two methods of subway ventilation. Ills. Serial. 1st part. 1800 w. Rev Indus—March 19, 1910. No. 13332 D.

Switzerland.

The History of the Seebach Wettingen Railway. W. J. Finke. Brief history of an experimental electric line which gave successful operation, but for financial reasons went back to the use of steam. 2500 w. Minn Engr—March, 1910. No. 13078 C.

Terminals.

The Two-Story Street Railway Terminal of the Public Service Railway, Hoboken, N. J. John M. Barney. Plans, sections, illustrations and description of a large terminal building under construction. 1000 w. Eng News—April 21, 1910. No. 13265.

Track Construction.

City Track Construction. W. A. Heindle. Read before the Iowa St. & Int. Ry. Assn. The types and methods described refer to recent work in the cities of Davenport, Rock Island, and Moline. 2000 w. Elec Ry Jour—April 23, 1910. No. 13299.

City Track Construction for Electric Interurban Railways. H. L. Weber. Abstract of a paper read before the Central Elec. Ry. Assn. Gives plans for satisfactory track construction in city streets. 1500 w. Eng News—April 14, 1910. No. 13104.

Track Maintenance.

Tramway Track Maintenance and Renewal. Henry Mattinson. Deals with the causes of deterioration, particularly in regard to damage by water, and the way it may be prevented. Ills. 4000 w. Surveyor—April 15, 1910. No. 13449 A.

Department of Maintenance of Way and Buildings—Metropolitan Street Railway Company. Illustrated account of the organization and work of this department. 4000 w. Elec Ry Jour—May 7, 1910. No. 13767.

Vienna.

Projects for Improving Traffic Facilities in Vienna (Vorschläge zur Verbesserung der Wiener Verkehrsverhältnisse). Karl Hochenegg. Describes present conditions and discusses possible improvements. Ills. 6500 w. Zeitschr d Oest Ing u Arch Ver—March 25, 1910. No. 13300 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE TWELVE PRINCIPLES OF EFFICIENCY

AND THE ORGANIZATION WHICH MAKES THEIR APPLICATION POSSIBLE.

By Harrington Emerson.

In a preceding article, the first of this series, Mr. Emerson showed by historic examples the universal potency of certain efficiency principles. His examples were Prussia's unprecedented course of military conquest, Japan's marvellous success in war, and the industrial advance in both countries following the same policy of constructive organization and application of the "Twelve Principles." These principles are so certain in effectiveness that, in Mr. Emerson's words, they "give even the mediocre manager a greater possibility of attaining high efficiency than was ever possessed by the greatest industrial geniuses working along the old lines."

The application of these principles requires a special type of organization. It is not generally possible to introduce them until, by amending or supplementing the existing order, this constructive, defensive, functional type of organization is secured. The article now presented shows by natural analogy and contrast wherein the efficiency organization differs from the old military type. The succeeding papers will take up successively the "Twelve Principles" and discuss their application in industrial management.—THE EDITORS.

THE poor white trash of the southern States and the listless negroes have long been a by-word, but we suddenly find out that all these people, white and dark, are afflicted with a parasite, the hook worm, which saps their vitality, internally slowly bleeds their strength away.

The remedy is not schools, nor churches, nor the suppression of the saloon, nor the sternness of the task master—all excellent devices; the remedy is the elimination of the parasite. After this initial betterment, the principles of education, of religion, of temperance, of stimulus, may be confidently applied.

American organization for operation, whether governmental (army, navy, civil), whether state or municipal, whether for land-railroads or ocean-steamboats, whether educational or religious, whether industrial or commercial, proves on investigation to be inefficient, often disgracefully so, the efficiency of the output of men of militia age of the country as a whole being not more than 5 per cent, the efficiency of use of materials being not more than 60 per cent, the efficiency of equipment, facilities, averaging not 30 per cent. These inefficiency statements can be verified from the facts, by any competent experts, as readily as an assayer can duplicate the assay of an ore sample.

Our material resources are unsurpassed, our workers are intelligent, ambitious, versatile, our equipment, from farm lands to office buildings, from typewriters up to Mallet compounds and down again to telephones, is lavish; yet it is all depreciated by an equally stupendous inefficiency. The principles of efficiency are simple, are plain, are elementary; they have been accepted and practiced empirically for a few million years since life began on our planet; yet in modern America, we flounder in our productive operations, as hopelessly put back in the running as the hook-worm victim in the South.

What is this insidious disease that wastes our resources of materials, of human potentiality, of equipment—that prevents the application of efficiency principles even as the existence of the hook-worm prevents the application of principles of human well-being?

The industrial hook-worm disease is defective organization.

In the first essay of this series I have shown that a certain type of organization, whether applied to the development of empires or to industrial shops, produces very high efficiency. There is another type of organization, unfortunately the one almost universally adopted in our collective activities, which is incapable of applying efficiency principles; and the use of this type is responsible for much of modern inefficiency and waste. An air compressor, forcing hot and squealing air, and a vacuum pump softly coaxing cooling air, are one and the same machine working on the same cycle in opposite directions. With a few very simple changes the compressor can be changed into the vacuum pump. So with a few very small changes a disastrous form of organization can be turned into a beneficent form. We shall try to make clear the difference between these two forms of organization, to show why it is impossible for one type to apply efficiency principles and impossible for the other type not to apply them, to show that from the beginning of life the efficient type has always produced better results, and that a long step forward towards conservation will have been taken when we adopt for our collective life the superior type; to show that the change from one type to another is radical only in theory, not in operation—not at all such a change as substituting electric traction for steam traction, a prohibitively costly undertaking; much more such a change as substituting a north window with its mellow diffused light for a south window with its fierce glare and shadows.

In primitive times, with that fatuity and perversity which unaccountably characterizes so much that is human, we turned to the left when we ought have turned to the right. Having two forms of organization to choose from—only two, the destructively offensive and the constructively defensive—we chose for our industrial organization the destructively offensive type, and it does not work out, never can and never will; while we ought to have chosen the constructively defensive type of organization, alone suited to productive upbuilding.

The two types of organization are as old as life, are therefore far older than humanity, and we have had to accept them as part of our inheritance just as we accept the necessity of assimilation, of elimination, of reproduction, of breathing. But there is no more reason in adhering industrially to the destructive type of organization, since we have learned that the other is better, than there is in adhering to pack teams and ox carts after the railroad and automobile have been perfected.

To bring out clearly the radical differences between the two types of organization, in spirit, in effectiveness, and in methods, we select two primitive examples, one a plant and the other an animal. The plant trusts to the generous, often enthusiastic co-operation of forces outside of itself and it therefore draws strength of wide and unlimited range. The mammal trusts to the occasional, often grudging, co-operation of powers identical in kind with its own, therefore of limited scope. The pathfinder through primeval forest is impressed with the luxuriant wealth and profusion of plant life—trees, at their best, 400 feet high; is impressed with the comparative paucity, pettiness, transitoriness of animal life, whose largest jungle representative is the elephant, twelve feet high and living at most a few hundred years. Plants trust all nature and draw help from everywhere; animals trust none but their kind and grow through destruction. Even that type of all that is silly and innocent, the sheep, will destroy in a few years a millennial pasture range.

The wild rose bush exemplifies the defensive, upbuilding type, of organization. The rose stems are covered with sharp thorns so that the delicate flowers may not be plucked and destroyed by wanton creatures who might just as well be browsing on grass or leaves, but the color and perfume of the blossoms attract the bees, beetles, butterflies, and moths who in return for an efficiency reward, the honey, cross-fertilize the plants. The petals fade and drop, the seed receptacle, an inconspicuous green, swells and grows. When ripe, the leaves that hid it fall away; it appears red, a tempting rose-apple to bird that plucks it, to mammal that finds it dropped, but the cradle of the seeds is so protected that the rose babies escape to grow and flourish where they fall. The rose relies on defensive up-building organization, calling on water, air, warmth and light, earth, insects, birds and mammals, each taking a part, all helping the rose to dot the western prairies, to deck the roadsides and moors of the New England seaboard, to blanket the lovely North Pacific Coast.

Roosevelt gives us the other picture when he describes the African baboons who are organized for offense, for destruction:

> The baboons were very numerous around this camp, living both among the rocks and in the tree-tops. They are hideous creatures. They ravage the crops and tear open new born lambs to get at the milk inside them; and where the natives are timid and unable to harm them they become wantonly savage and aggressive and attack and even kill women and children. In Uganda, Cuninghame had once been asked by a native chief to come to his village and shoot the baboons, as they had just killed two women, badly bitten several children, and caused such a reign of terror that the village would be abandoned if they were not killed or intimidated. He himself saw the torn and mutilated bodies of the dead women; and he stayed in the village a week, shooting so many baboons that the remainder were thoroughly cowed.

Baboons do not act singly, but in bands with leaders, with sentinels posted. Baboons, wolves, wild dogs and primitive man are thoroughly organized for offense and destruction. It is because the object is offense and destruction that evil characteristics are most prominent—arbitrariness, irresponsible exercise of power, harshness, cruelty, with anarchy all along the line.

Some strong male, differing not in kind but merely in degree from his fellows, has fought his way to the top, is given allegiance, based partly on fear, partly on self-interest. He delegates power, or each lower rank of followers usurp power, and this results in anarchy all along the line. Are we now writing of the African baboons, of the wolf pack, of the paleolithic war chief, of the neolithic hunting, foraging, plundering, filibustering chief, of the enterprising New York Madagascar trader, of the respectable Rhode Island slave and rum trader and privateer; or are we writing of Roosevelt's land and marine experiences as a Rough Rider with our army and navy; or are we writing of the shops of the great industrial incorporations, of the operation and maintenance of our railroads? It is all one and the same thing, as they all are victims of a common type of organization resting on the same principles—individual arbitrariness at the top, usurped and delegated power down the line, anarchy everywhere.

Modern men have lost the fangs and the cruel hands of the baboon; in them also his savage, cruel instincts are softened. Modern sea captains are not such monsters of cruelty as Henry Morgan, modern generals are not as ruthless as Caesar, Attila, Genghis Khan, Tilly, or even Napoleon. Men, thoroughly good, conservative, upright men, with every great upbuilding instinct, are happily at the head of most of our great institutions; they are infinitely better than the destructive organizations through which they are compelled to work, knowing no other; but the old danger is always latent. We who know could fill volumes with modern illustrations of the ever out-cropping evils due to the destructive type of organization.

Let all who wish to become acquainted with a detailed story of humiliating inefficiency, due to arbitrary incompetence—at the top, mitigated by usurped power and anarchy everywhere, read the appended extracts from Roosevelt's Rough Riders.*

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* "The battalion chief of a newly raised American regiment, when striving to get into a war which the American people have undertaken with buoyant and light-hearted indifference to detail, has positively unlimited opportunity for the display of 'individual initiative.' . . . . . If such a battalion chief wants to get anything or go anywhere he must do it by exercising every pound of resource, inventiveness, and audacity he possesses. The help, advice, and superintendence he gets from outside will be of the most general, not to say superficial, character. He will have to fight for his rifles and his tents and his clothes. He will have to keep his men healthy largely by the light that nature has given him. When he wishes to embark his regiment, he will have to fight for his railway cars exactly as he fights for his transport when it comes to going across the sea; and on his journey his men will or will not have food, and his horses will or will not have water and hay, and the trains will or will not make connections, in exact correspondence to the energy and success of his own efforts to keep things moving straight.

"It was on Sunday, May 29 at San Antonio, Texas, that we marched out of our hot, windy, dusty camp to take the cars for Tampa. There were no proper facilities for getting the horses on or off the cars, or for feeding or watering them; and there was endless confusion and delay among the railway officials. The railway had promised us a forty-eight hours' trip, but it was four days later that we disembarked, in a perfect welter of confusion. Everything connected with both military and railroad matters was in an almost inextricable tangle. There was no one to meet us or tell us where we were to camp, and no one to issue us food for the first twenty-four hours; while the railroad people unloaded us wherever they pleased, or rather wherever the jam of all kinds of trains rendered it possible. We had to buy the men food out of our own pockets, and to seize wagons in order to get our spare baggage taken to the camping ground which we at last found had been allotted to us. . . . . .

"It was the evening of June 7 when we suddenly received orders that the expedition was to start from Port Tampa, nine miles distant by rail, at daybreak the following morning; and that if we were not aboard our transport by that time we could not go. We had no intention of getting left, and prepared at once for the scramble which was evidently about to take place. As the number and capacity of the transports were known, or ought to have been known, and as the number and size of the regiments to go were also known, the task of allotting each regiment or fraction of a regiment to its proper transport, and arranging that the regiments and the transports should meet in due order on the dock, ought not to have been difficult. However, no arrangements were made in advance; and we were allowed to shove and hustle for ourselves as best we could, on much the same principles that had governed our preparations hitherto.

"We were ordered to be at a certain track with all our baggage at midnight, there to take a train for Port Tampa. At the appointed time we turned up, but the train did not. . . . . .

"We now and then came across a Brigadier-General, or even a Major-General; but nobody knew anything. Some regiments got aboard the trains and some did not. . . . . . At six o'clock some coal cars came by and these we seized. By various arguments we

The efficiency engineer meets everywhere the inefficiencies, losses, ravages, disasters, material and moral, always latent, often active in wrong organization. To illustrate by instances from experience:

The able president of a two-hundred-million-dollar corporation, hearing that piece work resulted in greater output than day work, ordered piece rates put in and made the basis of remuneration on a few days' notice. A disastrous strike followed, costing the corporation $2,000,000, the community being made to suffer from violence of all kinds by strikers and their sympathizers, by officials and their hirelings. This president would not have presumed to design a steam engine, perhaps not have presumed without advice to select a typewriter; yet he rashly acted on two of the most delicate problems that confront any modern corporation, *wages* and *efficiency reward.*

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persuaded the engineer in charge of the train to back us down the nine miles to Port Tampa. . . . . .

"The trains were unloading wherever they happened to be, no attention whatever being paid to the possible position of the transport on which the soldiers were to go. Colonel Wood and I had jumped off and started on a hunt, which soon convinced us that we had our work cut out if we were to get a transport at all. From the highest General down, nobody could tell us where to go to find out what transport we were to have. . . . . . The quay was crammed with some ten thousand men, most of whom were working at cross purposes. . . . . . .

The military attachés came out to look on—English, German, Russian, French and Japanese.

"We were allotted a transport—the Yucatan. She was out in midstream, so Wood seized a stray launch and boarded her. At the same time I happened to find out that she had previously been allotted to two other regiments—the Second Regular Infantry and the Seventy-first New York Volunteers, which latter regiment alone contained more men than could be put aboard her. Accordingly I ran at full speed to our train; and, leaving a strong guard with the baggage, I double-quicked the rest of the regiment up to the boat, just in time to board her as she came into the quay, and then to hold her against the Second Regulars and the Seventy-first, who had arrived a little too late, being a shade less ready than we were in the matter of individual initiative. There was a good deal of expostulation, but we had possession; and as the ship could not contain half of the men who had been told to go aboard her, the Seventy-first went away as did all but four companies of the Second . . . . . . The transport was overloaded, the men being packed like sardines, not only below but upon the decks; so that at night it was only possible to walk about by continually stepping over the bodies of the sleepers. The travel ration which had been issued to the men for the voyage was not sufficient, because the meat was very bad indeed. . . . . . The soldiers were issued horrible stuff called 'canned fresh beef.' There was no salt in it. At the best it was stringy and tasteless; at the worst it was nauseating. Not one-fourth of it was ever eaten at all, even when the men became very hungry. There were no facilities for the men to cook anything. There was no ice for them; the water was not good; and they had no fresh meat or fresh vegetables. . . . . .

"By next morning came the news that the order to sail had been countermanded, and that we were to stay where we were for the time being. What this meant none of us could understand. It turned out later to be due to the blunder of a naval officer. . . . . .

"Meanwhile the troop ships, packed tight with their living freight, sweltered in the burning heat of Tampa Harbor. There was nothing whatever for the men to do, space being too cramped for amusement. . . . . . So we lay for nearly a week, the vessels swinging around on their anchor chains, while the hot water of the bay flowed to and fro around them and the sun burned overhead. At last, on the evening of June 13, we received the welcome order to start. . . . . . We knew not whither we were bound, nor what we were to do . . . . . . We had a good deal of trouble with the transports. . . . . . One of them was towing a schooner, and another a scow. . . . . .

"We rolled and wallowed in the seaway, waiting until a decision was reached as to where we should land. On the morning of June 22 the welcome order for landing came.

"We did the landing as we had done everything else—that is, in a scramble, each commander shifting for himself. . . . . . There were no facilities for landing, and the fleet did not have a quarter the number of boats it should have had for the purpose. . . . . . Meanwhile, from another transport, our horses were being landed, together with the mules, by the simple process of throwing them overboard and letting them swim ashore, if they could. . . . . . One of my horses was drowned. The other, little Texas, got ashore all right. While I was superintending the landing at the ruined dock, with Bucky O'Neill, a boatful of colored infantry soldiers capsized, and two of the men went to the bottom, Bucky O'Neill plunging in, in full uniform, to save them, but in vain."—ABBREVIATED FROM ROOSEVELT'S ROUGH RIDERS. Pages 47-61.

He did not know that efficiency reward ought to be preceded by the careful, systematic, and expert application of eleven other principles, of which "Wages" is a minor element of one; he did not know that the eleven anterior principles were largely lacking in application in his company, and that conditions were not ripe for any form of efficiency reward; he did not know that even if his company had been fitted to adopt the principle of efficiency reward, it remained a momentous question as to what form should be used, piece rates being probably the last that a competent expert would recommend. He was not to blame. He had to make a decision, and he did not have an organization around him, over him, under him, that automatically prevented this mistake, equally disastrous to his company, to his employees, and to himself.

The general superintendent of one of the largest American industrial plants, tremendously successful through his great genius, power, ability, told me with pride that for five months he had refused to allow any shop tools or supplies to be bought. He boasted that a smith foreman, failing to secure on requisition flatter steel, had made flatters out of Krupp steel tires which he appropriated for this purpose. The tool account came down, it is true, but at what cost in man-wasted time with smooth files, and all other man-supply deficiencies—in diminished output from machine-wasted time due to defective belts and all other machine-supply deficiencies?

Industrial arbitrariness by the superintendent, delegated and usurped power in the foreman, anarchy all along the line!

There are more disgraceful examples that could be cited in which foremen plundered and swindled the men under them, debauched wives, violated homes, because the power to employ and discharge, to promote and reduce, to augment and to lower compensation, had been delegated to them. American trade unionism, with all its imported tenets of inefficiency, is in large part a justifiable collectivism, alone able to cope with some of the worst outrages to which individual wage earners have been exposed; and it is pathetic that these same wage earners, in resorting to unionism, have known no better than to adopt all the worst characteristics of the very organization against the evils of which they were rebelling.

A high American railroad official of great and long experience told me that no grievance committee of wage earners had ever come to him with what seemed unreasonable and unfair demands that he had not been able to find as the original incentive to their action the arbitrary injustice and tyranny of some insignificant local official, foreman, or boss.

I have intimately watched the inception, progress, and end of three railroad strikes. Twice they were precipitated by the arbitrary action of irresponsible, yet conscientious and able railroad officials. The money lost in these two strikes by the employing companies was sufficient to establish efficiency operation on every American railroad, and under efficiency operation strikes are inconceivable. The third road won its strike hands down because it spent for defense, preparation, and mitigation of evils, one-tenth the sums necessary in the other cases for war and destruction.

In American organization a successful man becomes president, he selects his staff, his cabinet and—he puts it up to them. Each in turn selects his staff of managers and—puts it up to them. The manager selects his superintendents, and passes the power and responsibility on to them. The superintendent selects foremen, and delegates to them the power "to make good." The foremen select their workmen, and transmit to them the power to do the thing the president really wanted done.

The man at the bottom, with the least spare time to plan, the least training, the least compensation, runs the whole affair. This is the type—so usual, so universal, that many will wonder that it is questioned. It is the baboon, the wolf-pack, type of organization and it is all wrong.

The wild rose, relying on allies outside of itself to aid it, has developed and flourished under the defensive up-building type of organization, but we need not go so far afield. Plant life has no monopoly of upbuilding organization. Among the baboons, among the wolves, among the foxes, among men, the defensive, the up-building type of organization also exists, but men have not applied it to business. In his family life, and he is a most worthy husband and father, the fox imposes maternity on his vixen companion. This is no delegation of power, for he is incapable of maternity. He imposes a tremendous responsibility and he gives the balance of his life to doing his part that she may make a full success of what he imposed on her. He protects, he provides, he feeds her, he watches over her. The organization is one for defense and up building, and without it life would perish from our planet. The vixen in turn imposes on her young the greater responsibility of life, but in so doing she assumes a crushing burden of obligation towards her offspring. She feeds them from her own body, she watches over them, she trains them and teaches them, and if need be, gives her life for them. She delegated nothing, but she imposed obligation and she gives the balance of her life that they may make a full success of what she unwittingly imposed on them.

There is of course authority running from top to bottom, authority commensurate with responsibility, greater and stronger authority than that inspired by fear, but though the cubs obey the mother and the father, the organization is one of defense, of up-building.

This is the type of organization von Moltke imposed on a Prussian army. He left apparently intact the predatory form; but he created *staff,* and though it was elementary and inadequate staff it made his stupendous achievements possible. Von Moltke realized that there were natural laws superior to any general orders of his, that the general orders would be effective in exact degree as they utilized natural laws to the best advantage. He therefore created a general staff of specialists, officers, students, experts, acquainted with and skilled in the knowledge of general laws, and it was with their knowledge that he outfitted his armies, planned his campaigns, and executed his designs. The plans of his general staff prevented the issuance of orders contrary to the laws of nature; it stimulated the issuance of orders in accordance with the laws of nature; just as effectually as wheel flanges keep locomotives on the track and as steel rails lessen wheel friction, so there was elimination of futile waste, the promotion of efficiency. It required no revolution, no tearing down of what was to change offense and destructiveness into defense and constructions. Bismarck's main aim was not to conquer Austria or France, but to build up Prussia and Germany, and an army with a new organization was the instrument.

That the race of foxes may endure forever, the vixen exists for the sake of her babies, not they for her; father fox exists for the sake of the vixen and her special task, not she for him.

The stone, spear or sword was distinctly an adjunct to primitive man, but just as distinctly modern man is an adjunct to the machine tool, to the locomotive, to the twelve-inch gun. We would use them automatically if we could, and dispense with the man, even as we now drill oil and gas wells two-thousand feet deep and dispense with a well digger. Having reversed the relation of worker to his tools, we must of necessity reverse the relation of officer to private, of official to employee; we must reverse the administrative cycle. The employee no longer exists merely to aggrandize and extend the personality of the employer, but the latter exists solely to make effective the totally different function of the employee.

Modern industry as distinguished from primitive industry is run with equipment. It is the locomotive that pulls the train, the car that carries the freight. They are there for this purpose, and this is the inspiration of their design, construction, operation and maintenance.

We would willingly dispense with the locomotive-engineer and fireman if we could; they are capable of something better than watching signals and shoveling coal. The only excuse for putting human beings on such work is that the equipment used still requires human supervision. Similarly, in the shop, the equipment and its purpose are the main considerations and the duty of the machinist is primarily to his equipment. As we rise in the line we find each higher grade legitimately existing solely for the benefit of what is below, not for the amusement of what is above. The foreman is there not to relieve the superintendent of responsibility, but to direct the men on the machines operating to repair the locomotives pulling the freight. The general manager is there for the sake of the superintendents, the vice-presidents are there for the sake of the managers and the president is there for the sake of the vice-presidents.

Ideals may have been imposed or have been conceived by the president—the plan, perhaps, to develop a continent. The instrument used is a corporation, whose efficiency reward is dividends earned by carrying freight and passengers. These ideals of development, of earning capacity, remain; but to carry them out natural laws must be observed, these laws being efficiently taught by those qualified by study and experience to teach and direct. The laws are applied by officials each of whom is servant to the men over whom he has directing control. In vain does president or vice-president, manager, or superintendent issue orders and delegate power under current organization. Knowledge and ability, desire and interest, become diluted with every spreading step.

It is within my knowledge that the able, conscientious, and indefatigable chief engineer of the greatest constructive enterprise the world has ever undertaken was advised that the efficiency was very low, not aggregating much over 50 per cent, and of the remedies. He was offered, free of charge, efficiency staff advice. He did not avail himself of this offer because he belonged to the old school, because he did not know that standards could be established, much less realized, although in sanitation he accepted fundamental organization and authority; and so the actual results under him are costing two hundred million dollars more than they should have cost if he had been von Moltke, if he had had von Moltke's conception of modern organization.

With milions of flowing details, each separately elusive as one among millions of buzzing insects, the task seems hopeless and staggers us by its immensity, until we remember that honey bees, the most independent of union workers, have, as a union, gratefully accepted efficiency administration; that deleterious mosquitoes have been suppressed at the Isthmus of Panama by preventing their birth; that the task of modern organization is to control millions of details through a staff of specialists who supplement each working unit from tool, machine, implement, up to president and to corporation.

The central part in railroading is the locomotive. The one essential for a locomotive is to stay on the track. This is an absolutely modern conception. There was no such idea in the centuries of the pyramids, nor even in the days of Napoleon and of Robert Fulton. Because it is modern, an organization has been created to see that it worked. One might evolve the operation of a modern railroad from the wheel flange. The presidents and their staffs dictate a few letters each day, perhaps a hundred thousand in all; but that rails may stay in place and resist the side pressure of the wheel flange, two-thousand five hundred million spikes are inspected every day by the humble track walker, and though the train runs under the supreme control of conductor, of engineer, of fireman (as much as the dray runs under the control of its driver) the difference lies in the fact that all the departments of track maintenance, of equipment maintenance, and half the operating department, exist solely for the purpose of moving the wheels on top of the rails, of transmitting safely 2,600 horse power through six half-inch squares of frictional contact.

This is a stupendous result empirically achieved, since as yet but little has been standardized as to either truck, motive power, equipment, or operation, and no cost efficiency standards have ever been theoretically established as possible ideals.

The defective wolf-pack type of organization is one in which a chief issues arbitrary orders to his subordinates expecting them some how or other to execute them. The perfected organization for industrial upbuilding and efficiency is one in which specialists formulate the underlying principles, instruct as to their application, and relentlessly reveal both their observance and neglect.

It is of minor importance how the knowledge and experience of specialists is made available for the control and guidance of all line officials. Independent accounting firms impose their checks on even the greatest corporations. Independent efficiency specialists might well impose more profitable and important checks on the greatest corporations. The same end might be attained of an efficiency engineer, advised by an efficiency board, holding a position of efficiency authority on a president's staff, even as comptrollers hold positions of authority as to accounting.

Accounting, however accurate and minute, cannot of itself bring about efficiency. It tries to evolve a standard by comparison, showing that on some other occasion the record was better, therefore presumably always possible.

No modern business presumes to run without some kind of accounting. This is embryonic recognition of the need of staff regulation. Accounting in all its phases is a minor division of one of the twelve efficiency principles, *trustworthy, immediate and adequate records*. The eleven other principles are none of them less important than records, some of them more important.

A modern undertaking of any kind will be prepared to operate efficiently when it reverses the cycle, when each minute operation can attract to itself all the required knowledge and skill in the universe. It is only through a qualified staff, applying as needed to every detail the twelve principles of efficiency, that the cycle can be practically reversed.

How, practically, should this staff be formed and made effectively operative? No patent medicine exists that is a universal tonic for all forms of debility. No two organizations are alike, either in their merits or in efficiencies, and the object of staff is to provide what is missing, whether in organization, recognition of efficiency principles, or their application.

It is evident that there ought to be a controlling efficiency engineer, even as there is a comptrolling accountant or auditor. The comptroller as to accounts acts as a funnel into which are drawn all the best experience of the world as to accounting, and after filtration it is carried authoritatively down the line and applied where needed. A competent librarian acts as an intermediary between all the knowledge of the universe collected in books, and the great miscellaneous reading public seeking information. An efficiency engineer ought similarly to act as a funnel, being equipped to gather from all available sources whatever is of operating value for the organization he is advising.

Just as it is the business of the comptroller to apply accounting principles, so is it the business of the efficiency engineer to apply to all operations the twelve principles of efficiency. The duty of the executive desiring efficiency, who has accepted the defensive, upbuilding type of organization by appointing an efficiency chief, is not to demand details but to demand a certain efficiency—whether 80, 90, 100 or 110 per cent—and he should make himself sufficiently familiar with the twelve efficiency principles to apprehend their bearing on ultimate efficiency, thus qualifying himself to second and make operative the plans of his expert. If he waives the attainment of any definite excellence, he may set up his own limiting standards as to each of the twelve principles and instruct his efficiency engineer to accomplish what he can under the limitations imposed. Everybody knows that a horse trotting a mile in two minutes can be secured, and that the mile will be trotted in this limit if every condition required for success is provided. On the other hand, a wagon may be loaded with 5,000 pounds, a mile measured over a bad road, and the horse and driver told to do the best they can. They may do well, but it will not be a two-minute performance. In operation, a whole plant—a whole railroad, for instance—can be brought up to the highest practicable efficiency if the principles are applied through a suitable organization. A defective organization and emasculated principles will attain correspondingly lower results, usually equally unsatisfactory to the executive and to his staff assistant.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

IV. ELECTRICAL EQUIPMENT.

Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. In June he took up water-wheels and the mechanical equipment of the power station. The present installment considers the electrical machinery, and in August he will review the transmission and distribution of current. The whole discussion is addressed not to the specialist in hydroelectric engineering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commercial associates.—The Editors.

IN modern high-tension power transmission, alternating current is practically exclusively employed, either single-phase, two-phase or three-phase, the last named being generally preferred. Induction, revolving-armature and revolving-field generators are used, and in nearly all cases they are directly coupled, either rigidly or flexibility, to the turbine shaft.

The induction generator derives its name from the projecting ends of the rotating element which are termed inductors. The chief advantage of this type lies in that there is no rotating winding, as both field and armature winding are stationary. The rotating element is simply a mass of iron consisting of a catch spider of two or more parts, and because of this design high peripheral speeds may be obtained. The armature winding usually employed is what is called a concentrated winding, there being only one slot per face per pole. These are usually wound for 2,300 to 6,000 volts and are generally two- or three-phase. The pressure wave of an induction alternator can be made to approach closely a pure sine curve, a factor of great importance in long distance transmission and also in connection with arc-lamp lighting systems. The efficiency for full and partial load is high; the regulation, however, is as a rule not as close as that of a revolving field generator.

The armature of the revolving armature type consists of laminated steel rings mounted on the rim of the wheel and punched in such a way that when assembled the complete armature core is pierced with slots for the reception of the winding. The fields of large alternators are made of two or more pieces, the division being either vertical or horizontal, so that the frame may be removed and the armature winding made accessible. In the revolving-field type, as the name indicates, the field revolves and the armature is stationary. This method of construction facilitates the insulation of the armature winding and requires that field current, instead of the armature current, shall pass through the collector rings and brushes. On account of this the revolving field alternators are especially adapted to high voltage for large current output.

According to the standardization committee of the American Institute of Electrical Engineers, the regulation of an apparatus intended for the generation of a potential, current, speed, etc., varying in a definite manner between full and no load, is to be measured by the maximum variation of potential, current, speed, etc., from the satisfied condition, under such constant conditions of operation as give the required full-load values. The regulation of an alternator is the percentage rise in voltage obtained by throwing off the entire non-inductive full load. The speed and excitation are of course constant. Good machines have a regulation of 6 per cent on non-inductive loads and 8 per cent on inductive loads, with a power factor of 0.85.

Where synchronous machines are connected to the transmission line, close regulation of the generators is very essential. As these machines run in synchronism with the generator, any sudden variation in generator voltage is transmitted to the synchronous apparatus which cannot respond owing to the inertia effect of the rotating element. If the changes are very sudden, the synchronous machine will fall out of step and eventually stop. For slight changes the speed of the synchronous machine will try to keep step with the generator; this action is known as "hunting."

Where the alternator is subject to great fluctuation in voltage an automatic regulator, such as the Tirrell or Thury, facilitates the regulation of the machine; that is, it automatically controls the exciter current to give nearly constant voltage at the generator terminals.

The efficiency of a generator is the ratio of the power output to the power input and is expressed in per cent; the average efficiency is in the neighborhood of 96 per cent, while in the best machines it is as high as 98 per cent.

It is the practice, particularly in plants supplying current for railway purposes, to operate the generators at 50 per cent overload; however, the highest efficiency is usually obtained at 20 to 25 per cent overload and we will find that European manufacturers do not underrate their machines, and rate them according to the capacities at the highest efficiency.

The most common frequencies used are 25 and 60 and depend chiefly upon the character of the service, the former being used for power purposes and the latter for lighting, as it does away with fluctuation, while it gives much trouble with synchronous machines such as rotary converters; therefore motor-generator sets are best adapted to sub-stations where 60-cycle transmission lines are installed.

In the last few years 15 cycles has been much used for railroading, particularly in connection with single-phase systems, and during the discussion of this subject before the American Institute of Electrical Engineers, in June, 1907, the principal arguments in favor of 15 cycles were given as

1.—An increase of 30 to 40 per cent in the output of a motor of a given size, and consequent reduction in the total number of motors required to operate a railway, and in the cost of equipment.

2.—Better performance of the 15-cycle motors, including higher efficiency, higher power factor, and better commutation.

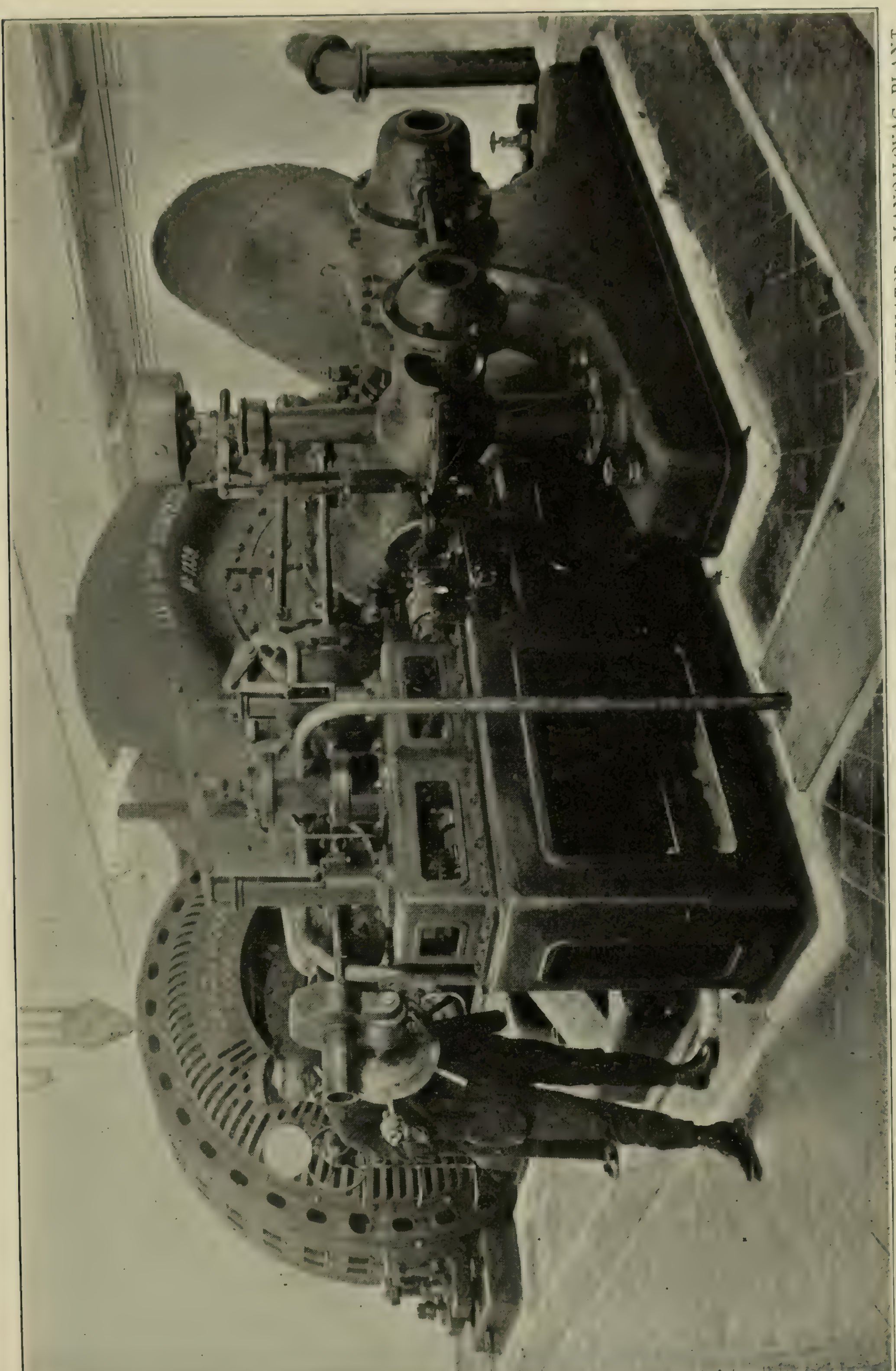
3.—Less dead weight to be carried on cars and locomotives.

4.—Lower line losses.

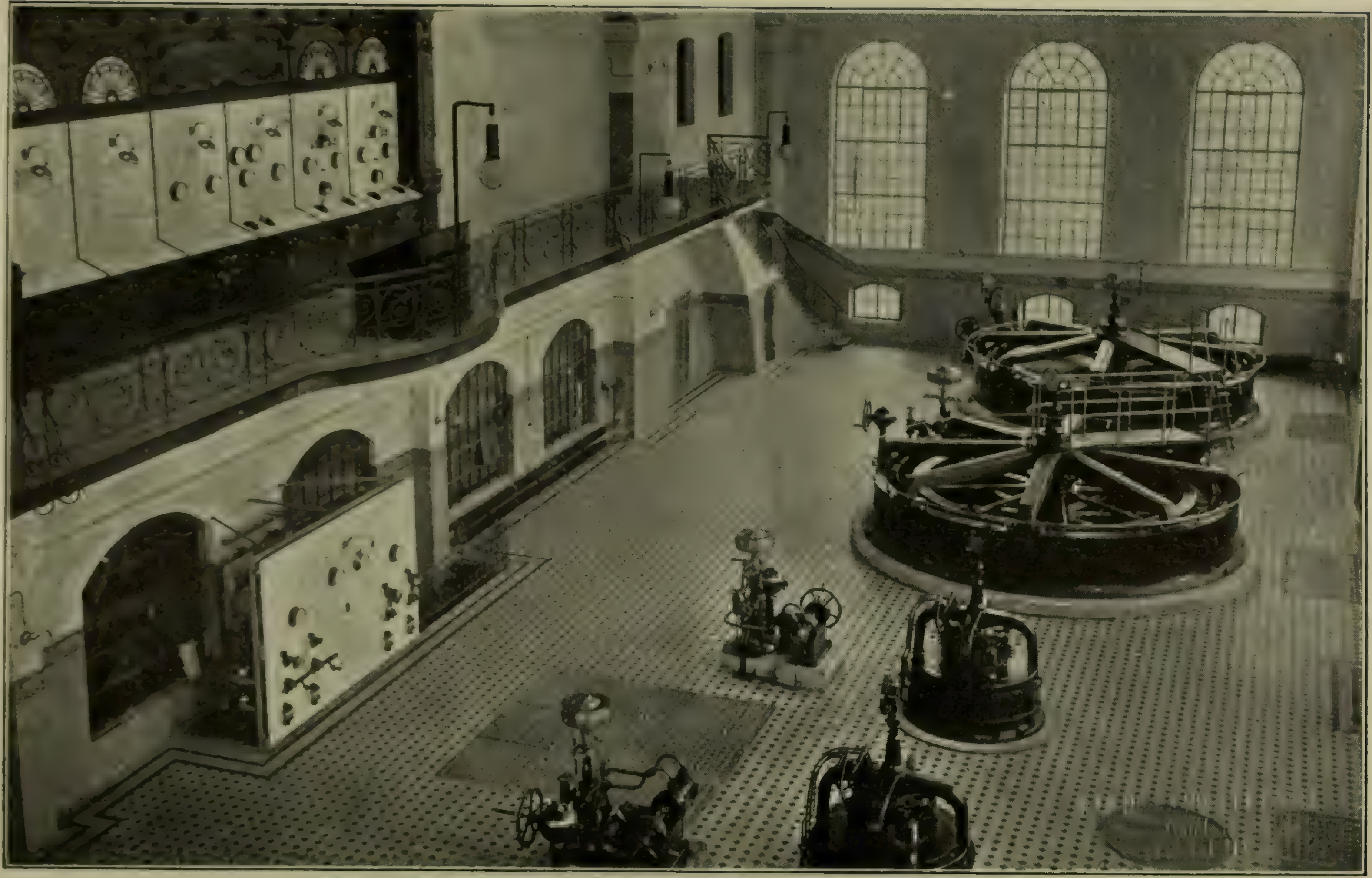
For low-tension distribution, voltages of 110, 220, and 440 may be considered as standard. For higher generator voltage, 1,100, 2,200, 3,300, 6,600, 11,000 and 12,000 are most frequently used in American practice.

While American engineers have been discussing the advantages and disadvantages of high-voltage generators feeding directly into a transmission system, it remained for the Continental engineers to design, construct, and operate such machines. Of the several high-voltage generator installations on the Continent of Europe which have been in operation for some years, probably the most prominent one is that at Manojlovac, Dalmatia. Here there are operating four 5,200-kilowatt, 30,000 volt generators directly upon a 21-mile aerial transmission line. Another plant where generators of 5,200 kilowatts and 30,000 volts will be found in equally successful operation is the plant at Subjago of the Anglo-Roman Lighting Co. of Rome, Italy.

The fear expressed by some engineers as to the possible unreliability of high voltage generators is consequently without foundation; to entertain such fear would seem to indicate a belief that expensive high tension transformers are the only reliable protecting devices for generators against lightning. Fortunately, there are numerous other devices for protecting the generators.

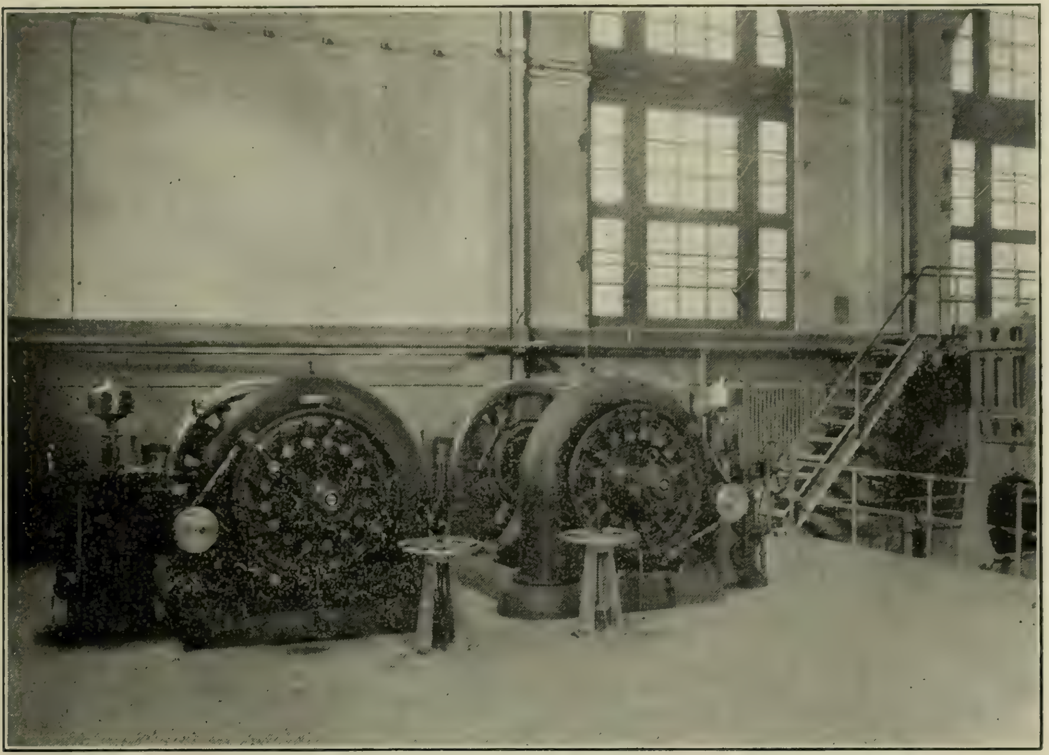


6,000 HORSE-POWER TURBINE DIRECT-CONNECTED TO 30,000-VOLT 42-CYCLE THREE-PHASE ALTERNATOR, MANOJLOVAC PLANT, DALMATIA.



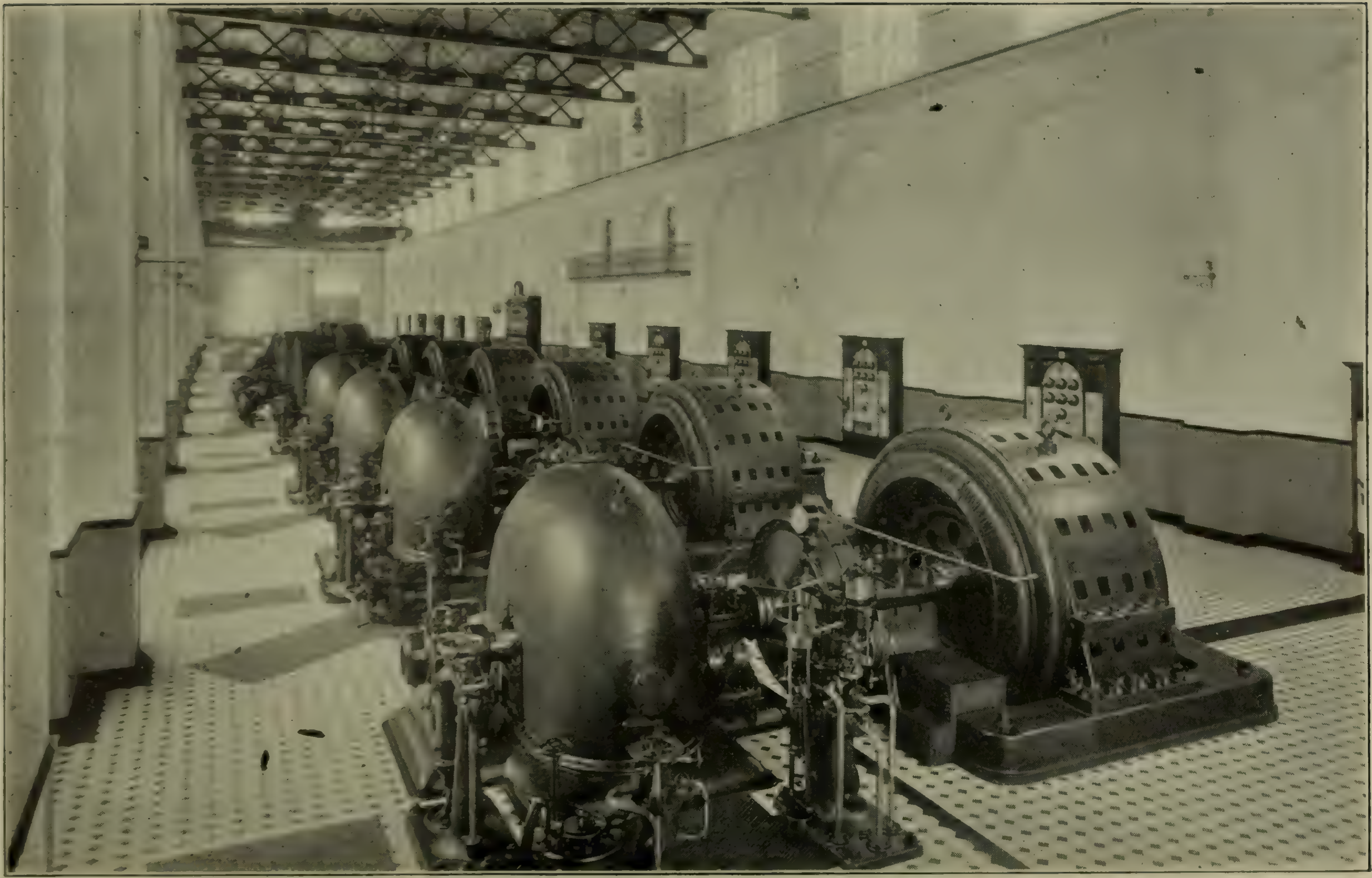
GENERATORS, EXCITERS AND SWITCHBOARD, KYKELSRUD, NORWAY.

The advantages of high-voltage generator plants lies in the low first cost, low operating expenses, simplicity of station wiring, and better line regulation; transformers and their attendant troubles are eliminated. A 30,000-volt generator is, of course, more expensive than a 6,000-volt or other low-voltage generator. However, taking into consideration the step-up transformers necessary with low-voltage generators, the single cost of a high-voltage generator outfit is lower; further, with the latter equipment the power house is smaller and therefore less expensive. The simplicity in station wiring is at once evident; there is no low-tension bus-bar system, with switches, transformer measuring instruments; therefore no special low-tension compartments are necessary. However, better and more expensive instrumental transformers are required. The operating performance of the station is simplified, there being no step-up transformers to look after when the generators are put into service; when the generators are to be run in parallel and thrown on the line, all that is necessary is to bring the incoming machine to synchronism and then throw it onto the bus. The absence of transformers relieves the system of surges attendant upon throwing unloaded transformers onto the busses.



150-KILOWATT 125-VOLT TURBINE-DRIVEN EXCITERS, SCHAGHTICOKE PLANT.

Exciters are driven either by separate turbines, or mounted upon the shaft of the main generator or belted to it. In the two cases



INTERIOR OF BROSSIA POWER PLANT, SWITZERLAND.

last-named the exciter is dependent upon the operation of the main unit, the disadvantage being that in case the speed of the main unit should drop the excitation is diminished, thus necessitating the installation of an automatic regulator.

PEDESTALS FOR GENERATOR INSTRUMENTS, OBERMATT PLANT, LUCERNE, SWITZERLAND.

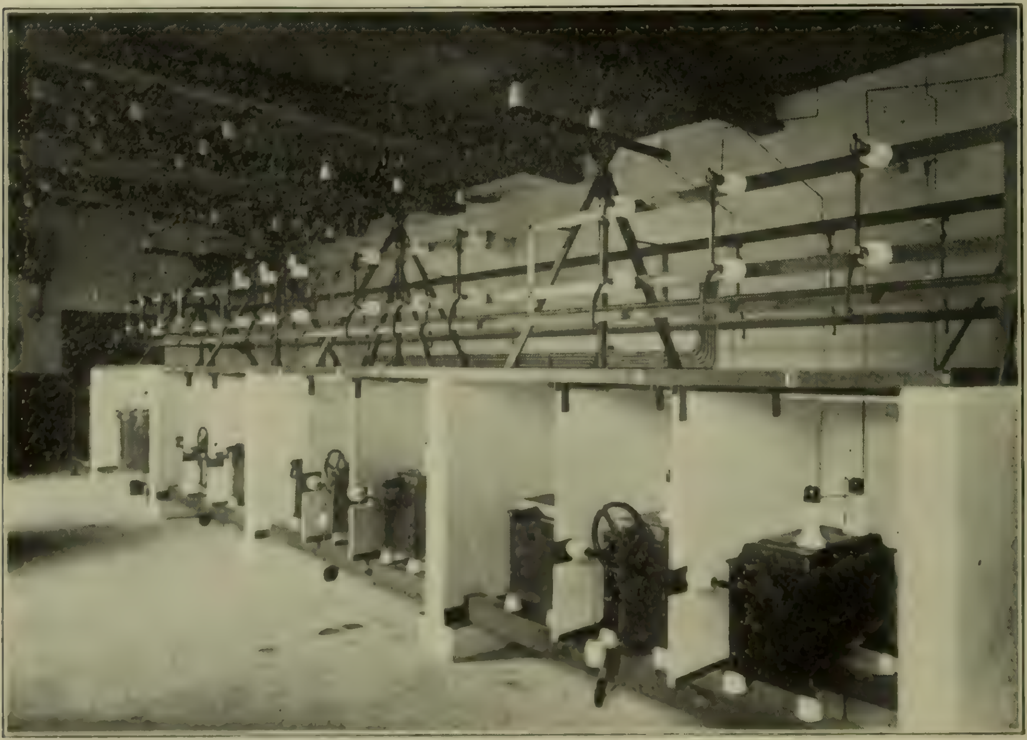
In connection with the exciters may be installed storage batteries, which float on the exciter busses to take care of fluctuations and peak loads. These storage batteries may simultaneously supply current for lighting the power house in emergency cases, and as frequently the circuit breakers are motor-operated, with remote control, the storage battery comes in handy for this purpose.

The generator leads to the switching room or switchboards should run as inconspicuously as possible, which result is secured by laying them either in trenches, tunnels, or in tile or iron conduits. The size of the leads is always specified by the manufacturer.

SWITCHING ROOM.

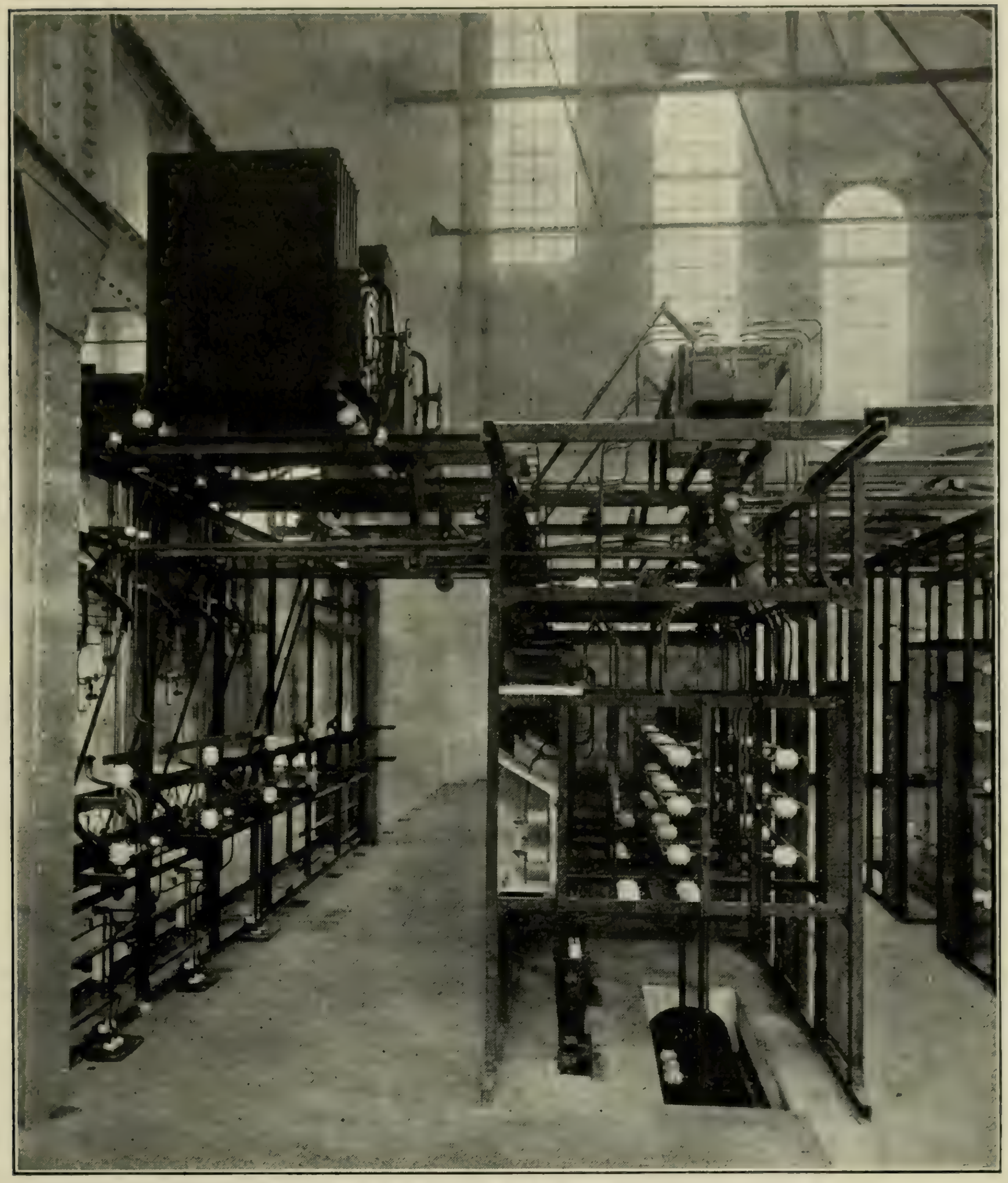
The switching rooms are located either in the power house itself or, in connection with large power plants, in a separate building. In such case only the controlling apparatus is located in the power-plant building, while the entire switch gear for the outgoing feeders is in the separate building located some distance away. Good examples of this kind are those of the Ontario Power Co. and the Canadian Niagara Power Co. In the majority of cases, however, the switching room is located alongside of the generator room so that the latter may be readily overlooked from the main switchboard operating gallery.

It is decidedly bad practice to have the whole switchgear located in a single room; it should be separated as to high and low-tension, transformers, etc., either by locating these on separate floors or by partition walls.



33,000-VOLT SWITCHBOARD, LEIZARAN, SPAIN.

The structure for the switch boards should be fire-proof and so arranged that easy access may be had to all parts to facilitate inspection and repair. The arrangement of the apparatus as well as the whole switchgear upon the panels must be simple and symmetrical to prevent as far as possible the making of wrong connections. The number of instruments and protecting devices must be sufficient to

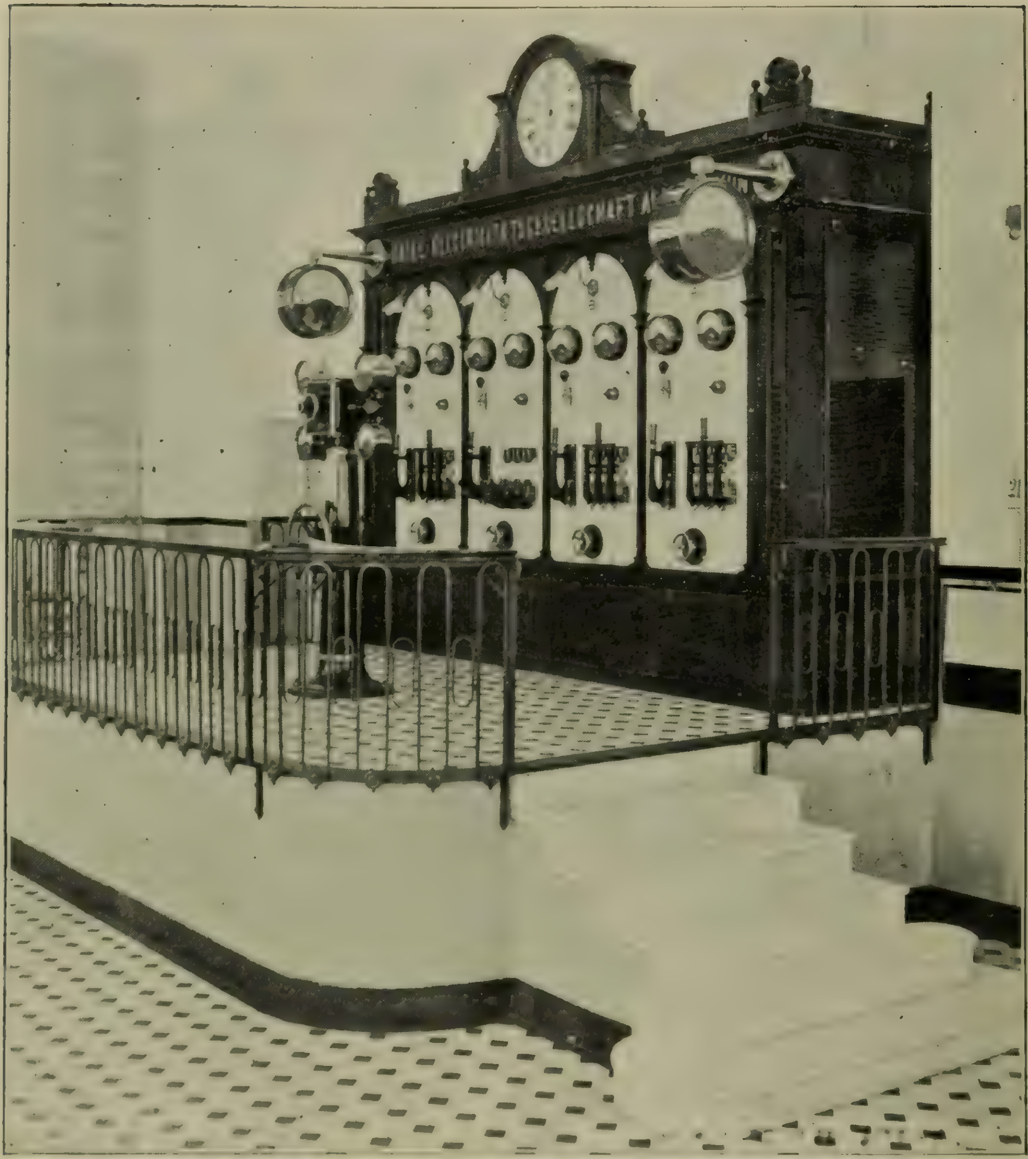


REAR OF SWITCHBOARD, KYKELSRUD PLANT, NORWAY.

secure a flexible and continuous operation. All live parts, especially those of high potential, must be eliminated from the front of the switchboard.

When laying out a switchboard, either for direct current or alternating current, each generator or machine must have its own panel, and the various panels for the same type of machines should be in separate groups. Provision must be made for further extension.

American and European practice are virtually the same in this direction. However, in the installation of one of the largest hydroelectric plants in Europe, that at Brusio, Switzerland, the direct



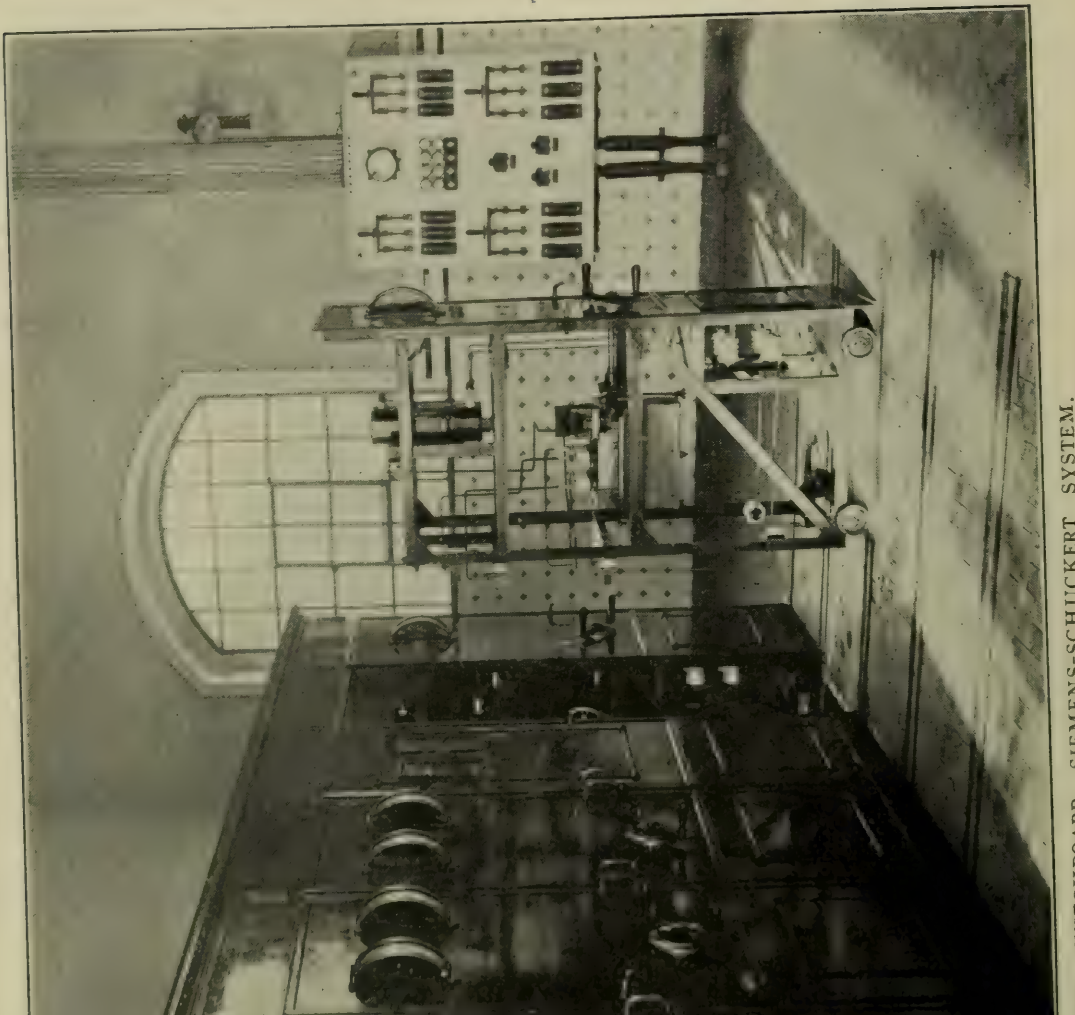
EXCITER SWITCHBOARD AND CONTROL PEDESTAL, BRUSIO PLANT, SWITZERLAND.

central system of switchboards has not been adopted, each generator having its own switchboard just opposite the generator. When the various generators work in parallel they are controlled from a single instrument pedestal in the front of the exciter switchboard in the middle of the generator room. This system was adopted because of the great number of generators installed. The generator attendants of the various machines look after the switchboards while the outgoing feeders, of which there are but few, are controlled from the central instrument pedestal.

The various types of devices for mounting switches and measuring instruments may be summed up as: the panel board, desk or bench board, pedestals or columns. For some years several types of "wagon" panels have been in use on the Continent of Europe. These consist of a carriage of structural steel upon which a panel, with the switches and instruments belonging thereto, are mounted; each such panel structure is provided with wheels so that it may be readily pulled away from the remainder of the switchboard, for inspection and repairs. The electrical connections are not disturbed thereby as the end of the panel structure is provided with knife switches so that by means of the heavy clips the circuits are made and broken. Danger of contact with live wires, etc., during inspection and repairs is avoided. This type of apparatus is shown on page 506.

35,000 VOLT SWITCHBOARD, HEIMBACH PLANT, GERMANY.

All power plants, whether small or large, where continuous operation is required, must have a double set of bus-bars or the equivalent, and the generator and outgoing leads to and from the bus-bars must be so provided with switches that current may be thrown on or drawn from either one of the bus-bar systems. An additional safeguard against interruption of service is to insert in each bus-bar system a sectionalizing switch. In high-tension plants where circuit breakers are used, section or hook-switches must be placed on either side of them so that they may be isolated for inspection or repairs. Where transformers are used it is advisable, particularly where there are a number, to have a bus on the outgoing



WAGON PANEL SWITCHBOARD, SIEMENS-SCHUCKERT SYSTEM.

feeder side. In American practice the double bus-bar system for outgoing feeders is seldom found, but will be found to a great extent in Swiss installations in the form of ring systems.

In one of the recent prominent German installations, that of the Heimbach plant, it will be found that there is no low-tension bus between the generators and the step-up transformers. Each 5,000-volt generator feeds through a fuse directly to its transformer. The consequence of this arrangement is that if a transformer is out of commission the particular generator is shut down, and vice versa. The high-tension side is tied together with a single ring bus-bar system, the ends of which are connected through choke coils. Between the transformers and the bus bar automatic circuit breakers are installed, and each outgoing feeder is provided with an automatic circuit breaker, choke coil, and three-pole tie switch. The whole is amply protected by lightning arresters. Considering the protection and particularly the flexibility of the high-tension side, it seems strange that the low-tension side should be so rigidly connected, and this plant may be seriously handicapped when a transformer, a generator, and a turbine of different groups are out of commission. although breakdowns are an unusual thing in Continental installations.

Bus bars are made up of cables or of flat bars of copper or aluminium, and in rare instances copper pipes are used when supports are far apart, as will be found in the Ontario plant. Flat bars, for mechanical reasons, are preferable to round ones as the connections are very readily made. The cross-section area of the bars of long bus bars may be made uniform and additional leaves added as each generator lead is joined to the bus bar, to give the required total area. The size of the bus bar is determined by the number of amperes it has to carry; from 700 to 800 amperes per square inch of copper is usually chosen as a safe value. If aluminium is used the cross-section area must be 1.66 times that of copper for equal electrical conductivity. For electrical reasons, also, the flat bars are to be preferred as they present a greater radiating surface per square inch of cross-section area, thus keeping the resistance, due to heating, from increasing. This is also a reason which favors open bus-bar compartments.

Bus bars are placed either in closed or open compartments of masonry. In closed compartments, openings of about 15 inches square are left and these are provided with iron doors. The open compartments, both for high and low-tension busses, are much in favor in Switzerland and Italy. This is due to the fact that more space is

6,000-VOLT BUS-BAR ROOM, OBERMATT PLANT, LUCERNE, SWITZERLAND.

devoted to the installation of the whole system, and that they prefer to have every high-tension apparatus exposed to view. Of course, wider aisles are therefore necessary. Installations of this kind, of 40,000, 50,000, and even 60,000 volts are found there, the latter being the highest voltage used there at present.

In modern switchboard engineering the most contradicting practice may be found. Oil switches of 600 volts are installed on the back of switchboards, operated by a lever, while on the other hand they are remote-controlled. Again, switches for 10,000 volts are mounted directly on the back of the switchboard; also, with 6,000-volt switches, the oil chambers of the individual phases are placed in large and very expensive masonry cells, the axis of which is well protected by especially designed fireproof doors; furthermore, with 50,000-volt oil switches, all phases are placed in a single sheet-metal tank, unprotected, and exposed to view. In addition to this the former is operated by a motor or solenoid, the latter by lever and rods. To go still further in citing the difference in practice, there are 60,000- and 80,000-volt circuit breakers in operation which have the phases in separate sheet-steel tanks exposed to view, being entirely unprotected by masonry construction so commonly used with 6,000-volt switches. Even 120,000-volt and 150,000-volt switches of the former type are advocated. From these contradictions in practice it will be observed that arguments as to the danger to the operating force from exposed high-tension apparatus are without reason, particularly if one bears in mind that practice has proven that 220 volts may cause death as readily as 30,000 volts or higher. It is evident from the above that much expenditure in first cost could be saved, also in maintenance and floor space in the design of modern oil switches or circuit breakers.

A high-tension oil circuit breaker is nothing more than an oil switch provided with an automatic opening device. The purpose of the circuit breaker is to protect the generator and transformer from overload, reversal of line current, and excess voltage, for which purpose overload relays, reverse circuit relays, and over-voltage relays are installed.

Overloads in most cases are caused by short circuits on a line; the common practice is to maintain the short circuit and burn it out. There are cases, however, where the short circuit can not be burned out and to maintain it would damage the line. To prevent long and excessive shorts from damaging the line, the circuit breakers are provided with overload relays, which will cause them to open in a certain set time after the short is established.

The reversal of currents is caused chiefly by synchronous apparatus connected to the line, such as synchronous motors and rotary converters. Cases sometimes arise that these machines instead of absorbing power will pump it back, and when this happens there is usually trouble, especially if there are underground conduits in the system. To prevent any damage from this source, the power-house circuit-breakers are provided with reverse-current relays, which cause the circuit breaker to open upon reversal of live current.

The over-voltage relay causes the breaker to open upon excess of normal voltage, due to over excitation or poor line regulation. The former difficulty is under the control of the operator, while the latter is under the control of the designing engineer and can be avoided.

GREGG WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY, SHOWING TEN OF THE KILNS.
Suggesting the improvements in fuel economy that are possible at all firebrick works.

STRIPPING AND MINING, UPPER CLAY BANKS OF THE DIDIER-MARCH COMPANY.

THE MINING AND FABRICATION OF FIRECLAY.

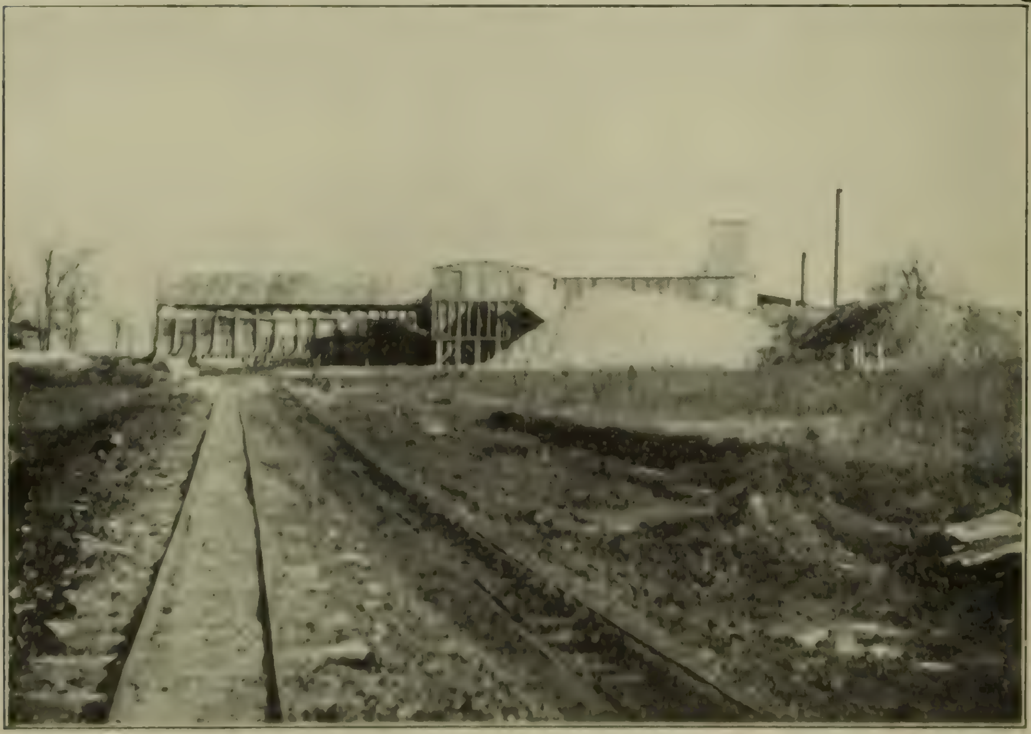
By A. S. B. Little.

Mr. Little's artice is prepared and published for the chief purpose of turning the attention of engineers and manufacturers to unrealized opportunities for profitable improvement in a great industry.—THE EDITORS.

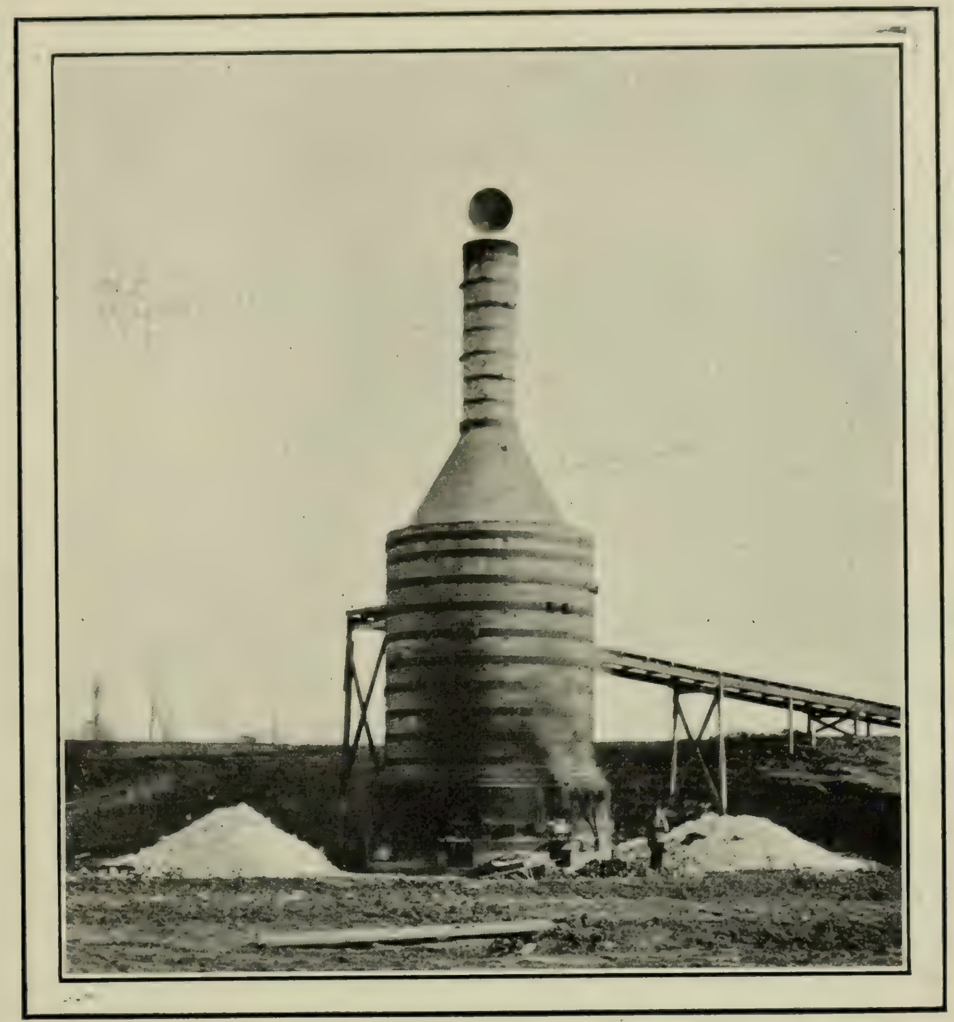
IF it were not for fireclay, engineering activities would be something like building operations without any foundation. If one gives the subject even a slight amount of consideration, it is obvious there is no single mineral which is of so much importance to engineering practice and progress as is this somewhat slighted "mud." The "mud man," as the manufacturer of fireclay products is called, is considered about equal in prominence and respect to the "hewer of wood and drawer of water," largely because people take his products without questioning why they are what they are, or how they could be replaced by any other mineral or combination of materials.

As a suggestion of the universality of the functions of fireclay, we might consider how a railroad train could be run from Chicago to New York in eighteen hours if the locomotive firebox were not lined with fireclay slabs.

This clay has been in use for centuries, and yet I believe the industry is one which lacks definite laws more than any other, including those which are either modern, or ancient and of less prominence. You can go to a manufacturer of steel and specify what you want by actual figures or statements, and you can check the product by chemical analysis or mechanical tests and thus make sure you get what you need. The producer knows how to combine certain elements, and what quantities of various kinds to combine, in order to get a result at least very closely approaching what you call for; but not so in the fireclay business. It is not entirely or evenly principally the fault of the fabricator or of the skilled employees in the trade, as to my knowledge on many occasions great efforts have been made both here and abroad to acquire definite knowledge of the nature of fireclay and its behavior under certain conditions. In America the Federal authorities have taken up the matter; in England a society has been formed amongst users and producers, and in Germany every sort of concentrated effort is being made, all with the idea of product



ONE OF THE TWO MINES, GREGG WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY.
Depth of seams, 75 ft.; thickness, 6 to 8 ft.; roof, 12 to 18 in. coal, and part shale and slate.

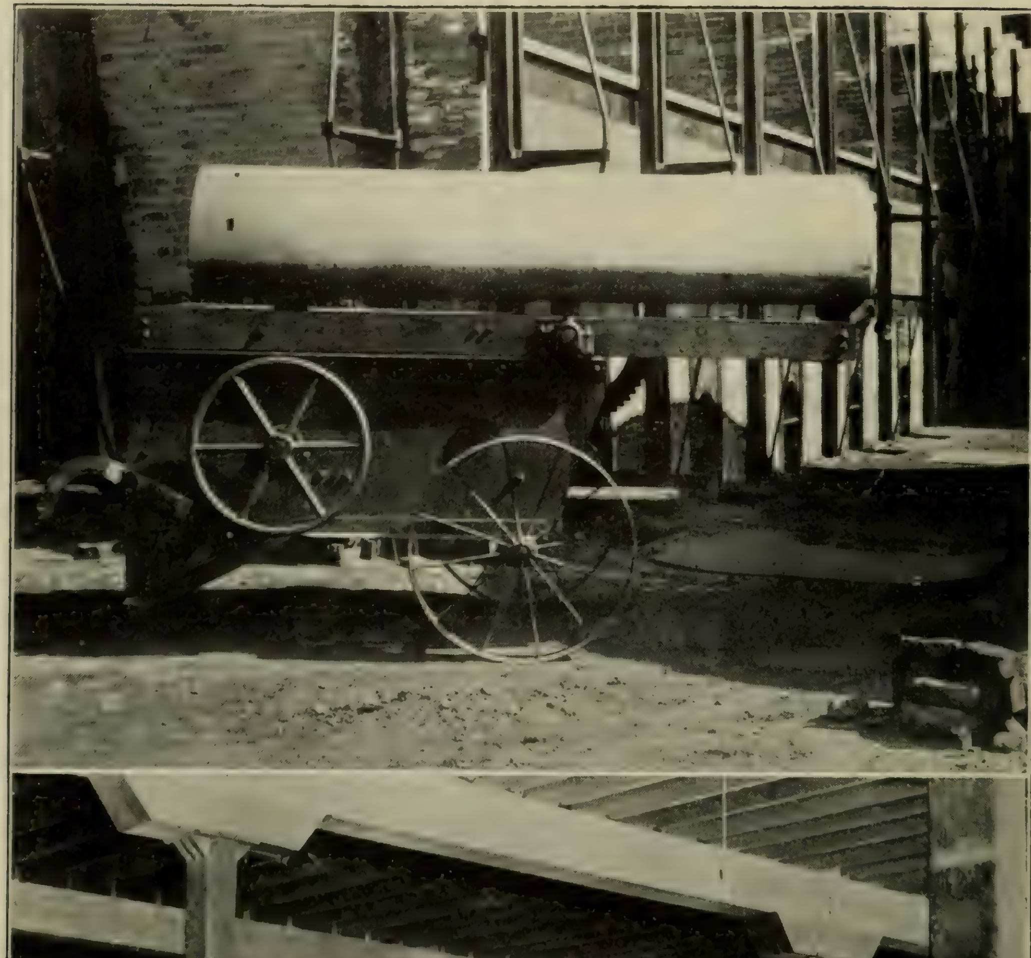


SPECIAL CALCINING KILN FOR REMOVING IMPURITIES FROM "FLINT" CLAY, EVENS & HOWARD COMPANY.

Note open coal-fire holes, and resultant waste of heat.

betterment. There is therefore every inducement for engineers to discuss the subject and give help where it is so much needed.

In the past, the most skilled and highest salaried chemists have been employed to make tests, to promote and carry thorough investigations on the natural product, and to study the workings of certain manufactured and elaborated articles derived therefrom. The result has been, generally speaking, confusion worse confounded. Two professors, working at similar times on brick or clay, obtained from the same source and manufactured under exactly equal conditions, have recorded diametrically opposed conclusions! The same scientist at different periods has reached vastly varying conclusions when testing identical qualities and shapes of bricks; so can you wonder if a prominent fireclay manufacturer should exclaim, as I heard one on an occasion after having the above experience, "All tests of fireclay are

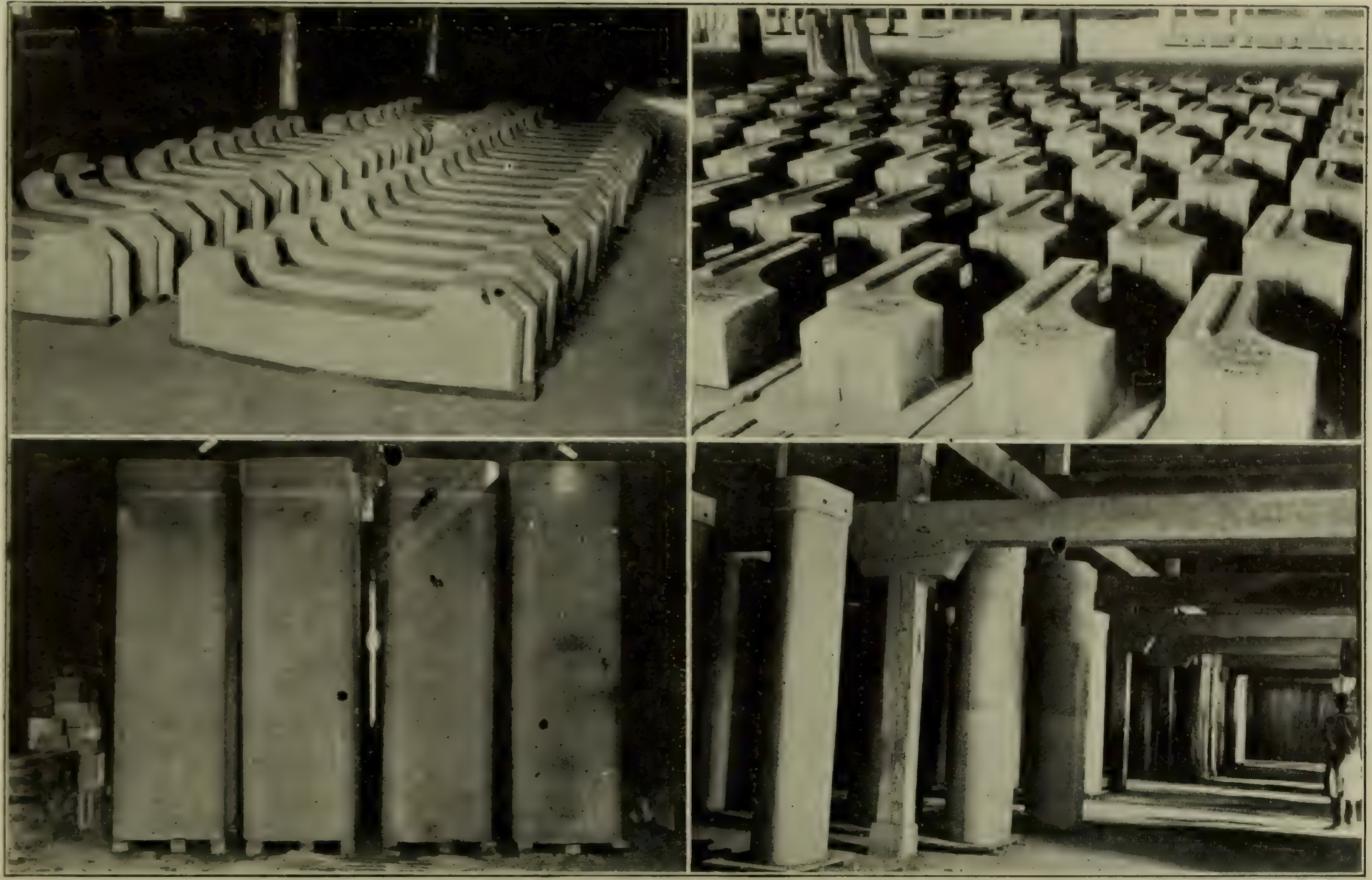


TRANSPORTATION OF MATERIALS AT THE GREGG WORKS.
Above, taking a retort from kiln to railway car. It has been burned three weeks at 2,700 degrees F. Size, 16 by 28 in. by 9 ft. 3 in. Below, trucks of bricks and dobies emerging from tunnel, where they have been drying in waste heat from one of the kilns.

empirical, and I would sooner trust our superintendent to pick and select his clays in the old fashioned way, than pay a high fee for a highbrow's recommendations." The chief method of testing fireclay by a practical man is literally to *eat it*. He can detect grit and sand best by that method, and a good fireclay, (free from silica, quartzite or flint clay) is free from grit. His only other personal test is by experiment.

It must be said, however, that the factory methods usually found in use at fireclay plants are lacking in those labor-, fuel-, and time-saving methods which are considered essential to success in every other modern up-to-date industrial concern. Also in the mixing departments, in the grading of the different sizes and kinds of clay and "grog," the element of guesswork is too much in evidence. The various dry pans are each worked separately, (at different times they are varied in their duty), on one of four or five classes of clay, and the various grades are then taken by chain and bucket elevators, and thence by belt conveyor to several overhead bins as described hereafter. No attempt is made to weigh or measure accurately the several kinds or sizes of clay or grog which it has been predetermined shall form a mixture for a brick or tile required to do a certain specified work. Also, beyond the elevator and conveyor from the mills to the storage bins, hardly any use of mechanically operated transport appliances is even attempted. The mills and pans are fed from wagons or barrows or both, all loaded and wheeled and dumped by hand and at the sweet will of a "Polock" or "Dago" as the cheap rough foreign laborer is called.

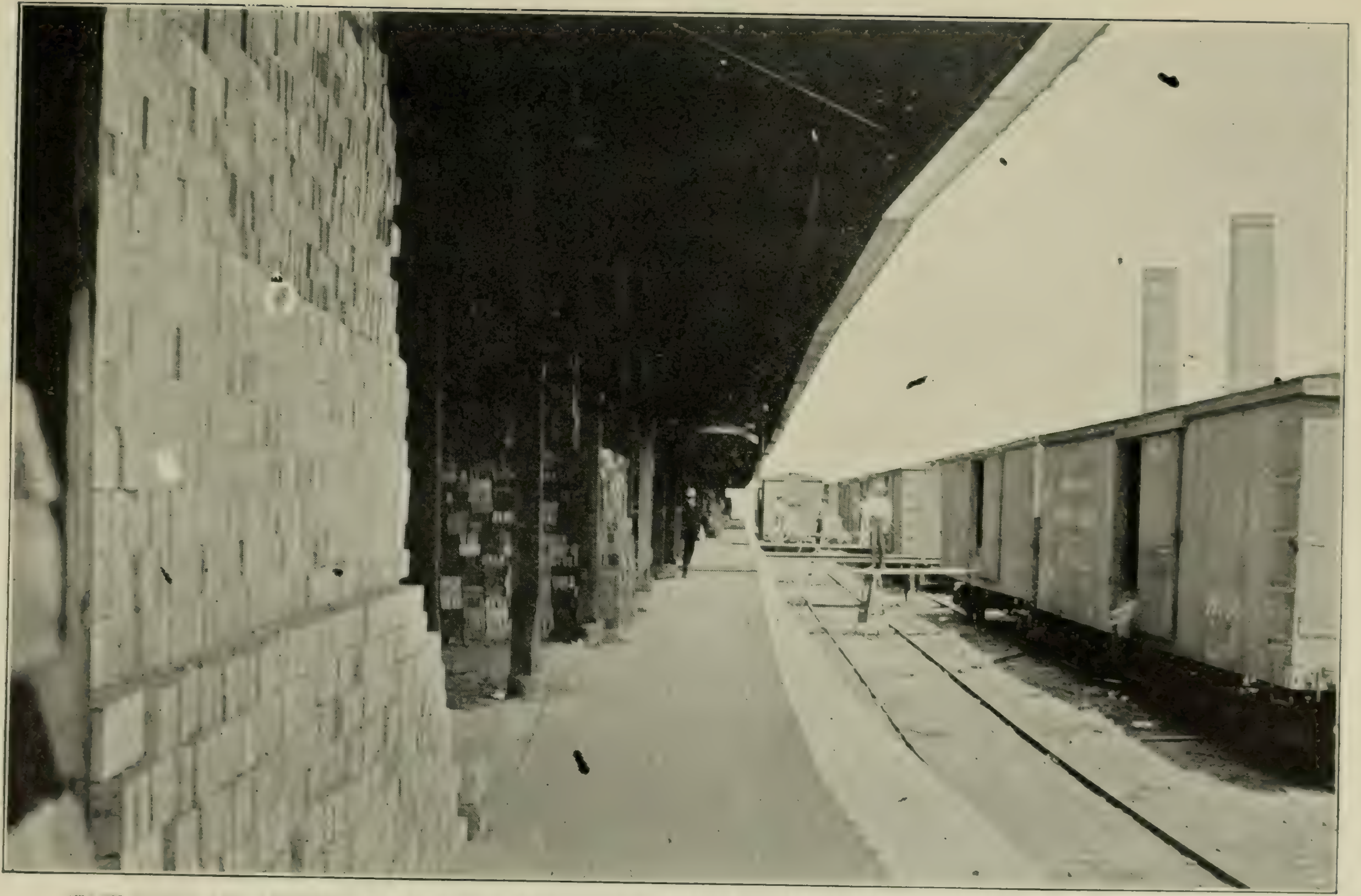
Then again, to see the way raw solid fuel is thrown on open fireplaces leading to circular or oblong kilns is enough to resurrect the immortal William Siemens. Coal is thrown out of coal cars, somewhere near a kiln *if possible*. It is hauled in wheelbarrows to (say) twelve fireholes in each kiln, and there may be forty kilns on a yard, each kiln approximately 24 to 30 feet diameter. Each fire is separately fired by hand, is hand-clinkered, and the ashes are handled in barrows when convenient and contain 10 per cent of combustible matter. The green bricks are handled by man power, on trucks, to the dryers, and are then carted in barrows to the kiln where they are hand stacked. After three days "smoking," two days firing and two days, (or more) cooling, (using about 1,400 to 1,600 pounds of coal per thousand brick) the burned brick or tiles are unstacked by hand, loaded on barrows, and placed by hand in railroad cars, or sometimes in the stock pile.



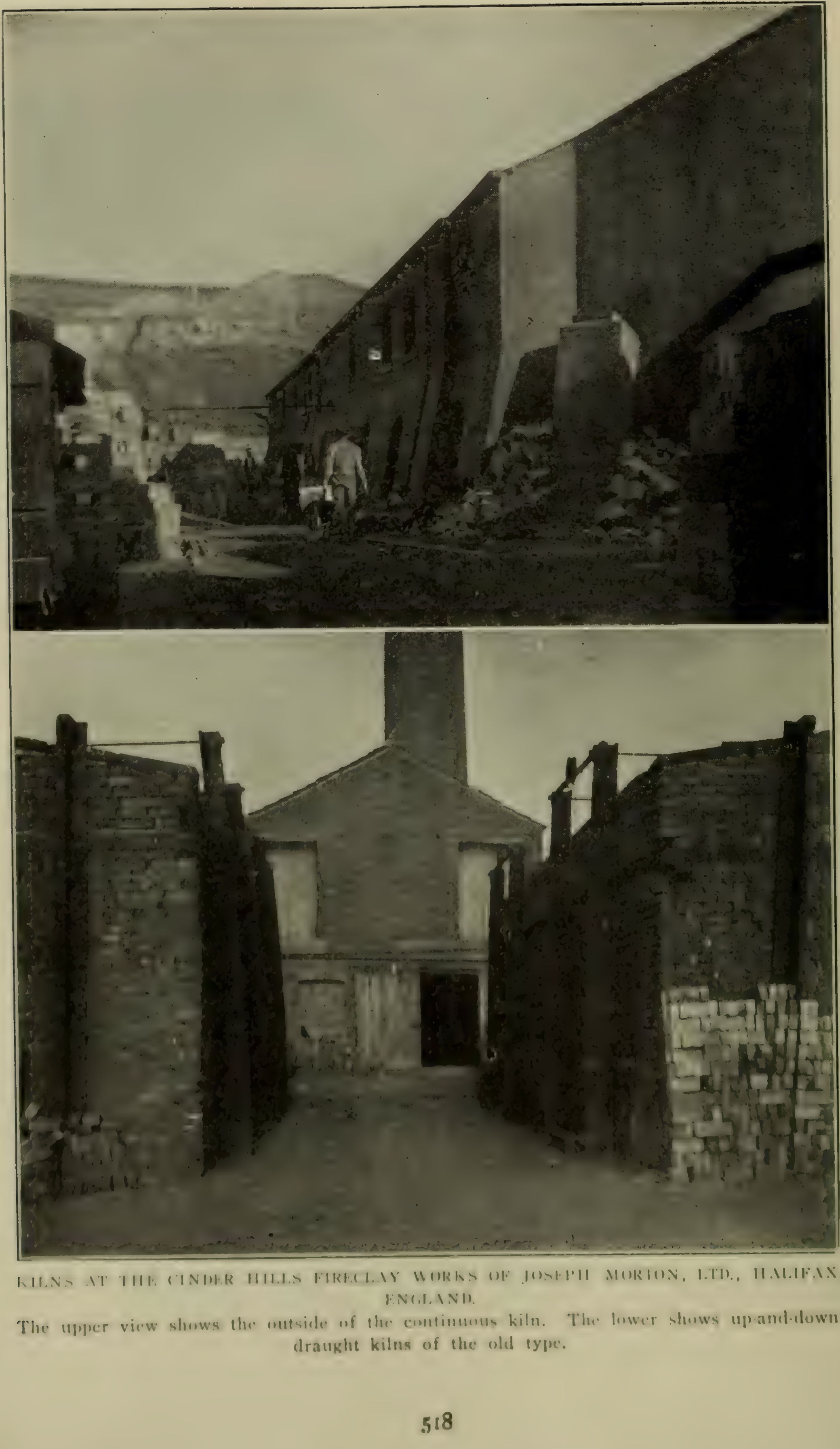
REFRACTORY PRODUCTS IN PROCESS OF MANUFACTURE AT THE GREGG & HOWARD WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY.

Locomotive tile. Quartzite tile

Retorts in kiln. Coal-gas retorts drying.



STOCK SHEDS AND SHIPPING PLATFORM, WORKS OF THE EVENS & HOWARD FIREBRICK COMPANY. ST. LOUIS, MISSOURI.
Showing the opportunities for economy by the installation of mechanical-transport appliances.

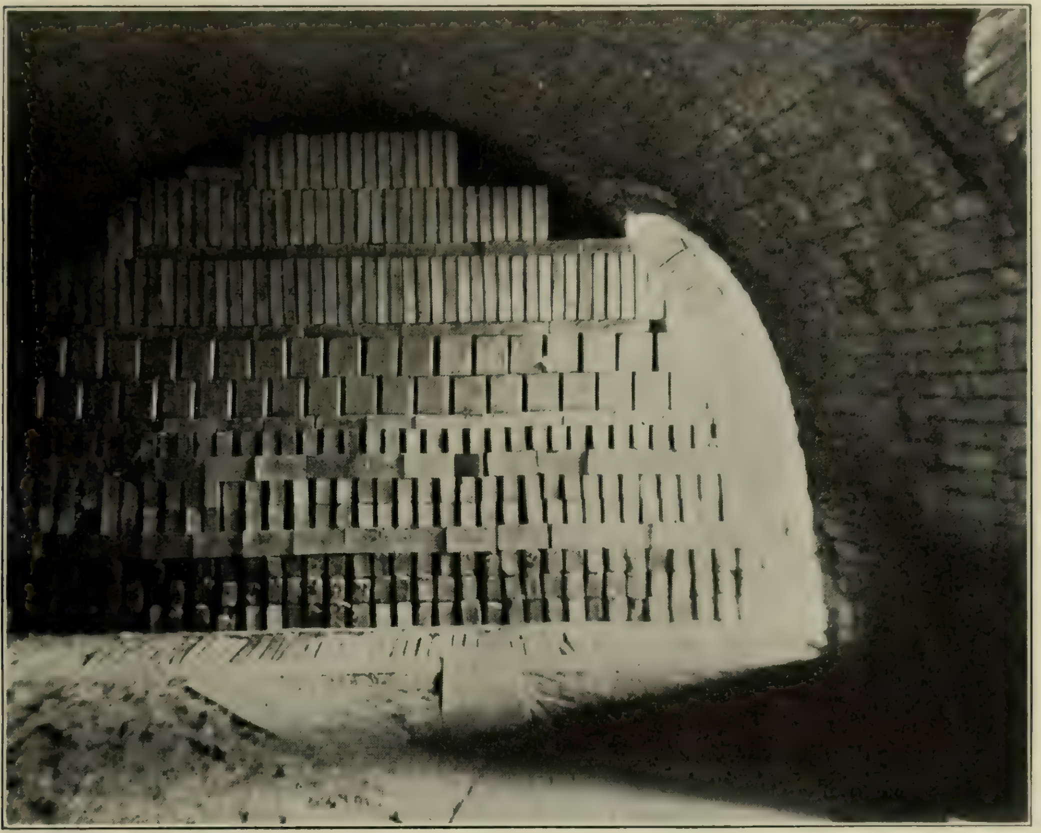


KILNS AT THE CINDER HILLS FIRECLAY WORKS OF JOSEPH MORTON, LTD., HALIFAX, ENGLAND.

The upper view shows the outside of the continuous kiln. The lower shows up-and-down-draught kilns of the old type.

It is with the object of securing the attention of some active and skilled engineer in a contemplative mood that the following general description of a fireclay factory is given. As in many other instances, the best help may be forthcoming from outside the trade. It is badly needed.

As Missouri contains perhaps the greatest producing district in the world, of clays which have never been surpassed in quality, let us select one of the factories there for our viewpoint, the choice falling on one of the most modern as well as the largest.



INTERIOR OF CONTINUOUS KILN, SHOWING METHOD OF SETTING BRICKS AND BLOCKS. CINDER HILLS FIRECLAY WORKS.

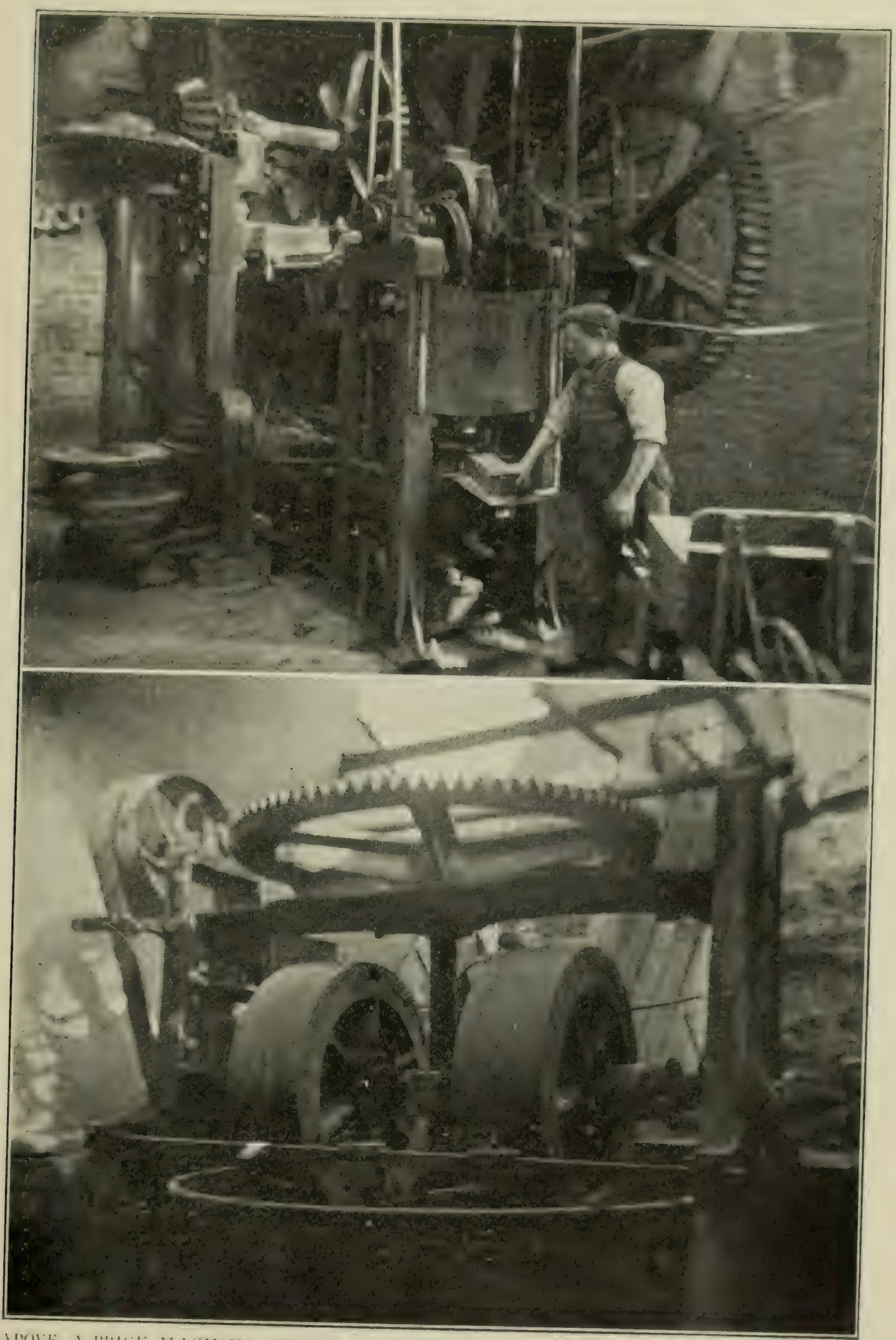
The selection of fireclays for different purposes has always been partly guesswork or rule-of-thumb, and even now in most works too much reliance seems to be placed solely on previous experience with certain beds or banks of clay. To this perhaps is due the fact that a manufacturer may go on for years supplying fireclay goods which have given wonderfully good results, and then suddenly there is a long string of complaints, generated through failure of the brick or tiles which may be made from what appears to be identical quality of clay, manufactured in the same machines, and with the same class of labor. In the language of the trade, a maker is then said to have "struck a bad seam of clay."

Excuses may be genuine but they do not make it any easier for the power producer to keep up steam when his Stirling or Babcock & Wilcox arch falls in.

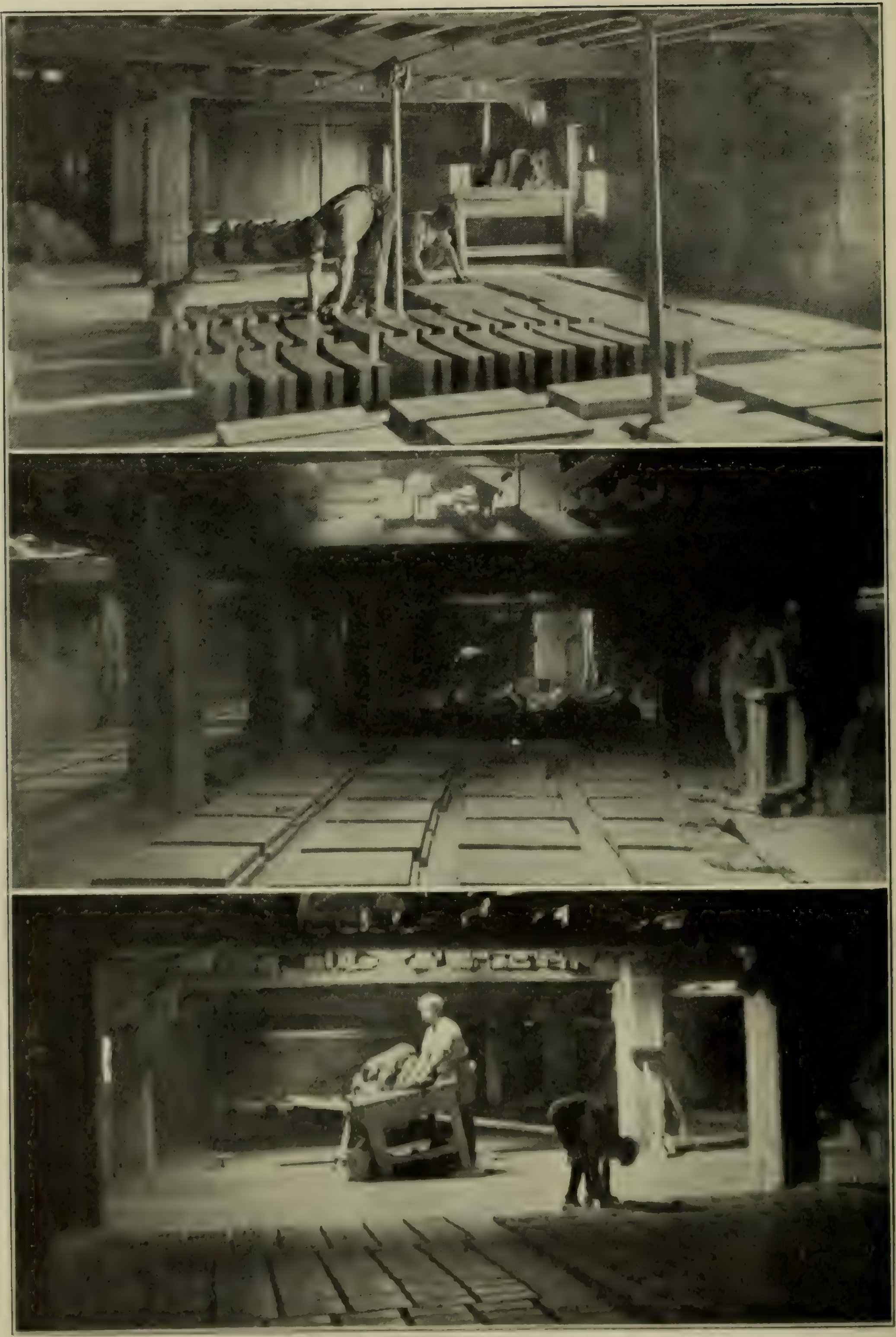
It is only fair to the manufacturer to say that users do not fully comprehend the risk they incur in ordering from the lowest bidder; and this, more than anything else, has tended to reduce the desire of up-to-date manufacturers to incur additional outlay for the purpose of being able to sell brick and tile on a specification basis. All the tests ever made on fireclay goods can result beneficially only if it is clearly demonstrated that manufacturers can find a market for the high-class and chemically correct grades of brick and tile. High price and long life would mean low cost. If the findings of such new kind of reliable tests show the need of better conductivity, increase in resistance to destruction by heat, and the ability to resist abrasion and destruction through mechanical friction or heat variation, then there might be found a means of getting makers to put forth their skill and experience, or to pay for that of others, besides laying out money to get the desired results. The firebrick business has a number of men who appreciate the desire for firebrick betterment, but the capitalists behind them have to be shown the business end of the proposition before permission can be obtained to carry out modern methods. This is hard on the idealists, but it is a straight business argument, and no company can afford to make perfect material unless the demand is there on a paying basis. This phase of the question should be carefully studied. When we consider, however, that in steel plants magnesite or chrome brick at $130 a thousand are now used in certain places where formerly a $25-a-thousand brick was used, there seems some hope of getting users to pay, say, $35 where they now pay $20 for other classes of fireclay or silica brick work.

The best known and most widely used Missouri clay is the Cheltenham plastic brand, although it is not the most refractory. It forms the base of nearly every class of firebrick, excepting only the all-flint brand, being composed chemically as follows:

Silica	46.48	per cent
Fe. Oxide	1.05	"
Alumina	33.52	"
Lime	.33	"
MgO	.28	"
Moisture	4.20	"
Volatile Matter and Combined Water	12.88	"
Alkalies	1.04	"
Titanium	.19	"



ABOVE, A BRICK MACHINE; BELOW, A GRINDING MILL. CINDER HILLS FIRECLAY WORKS.



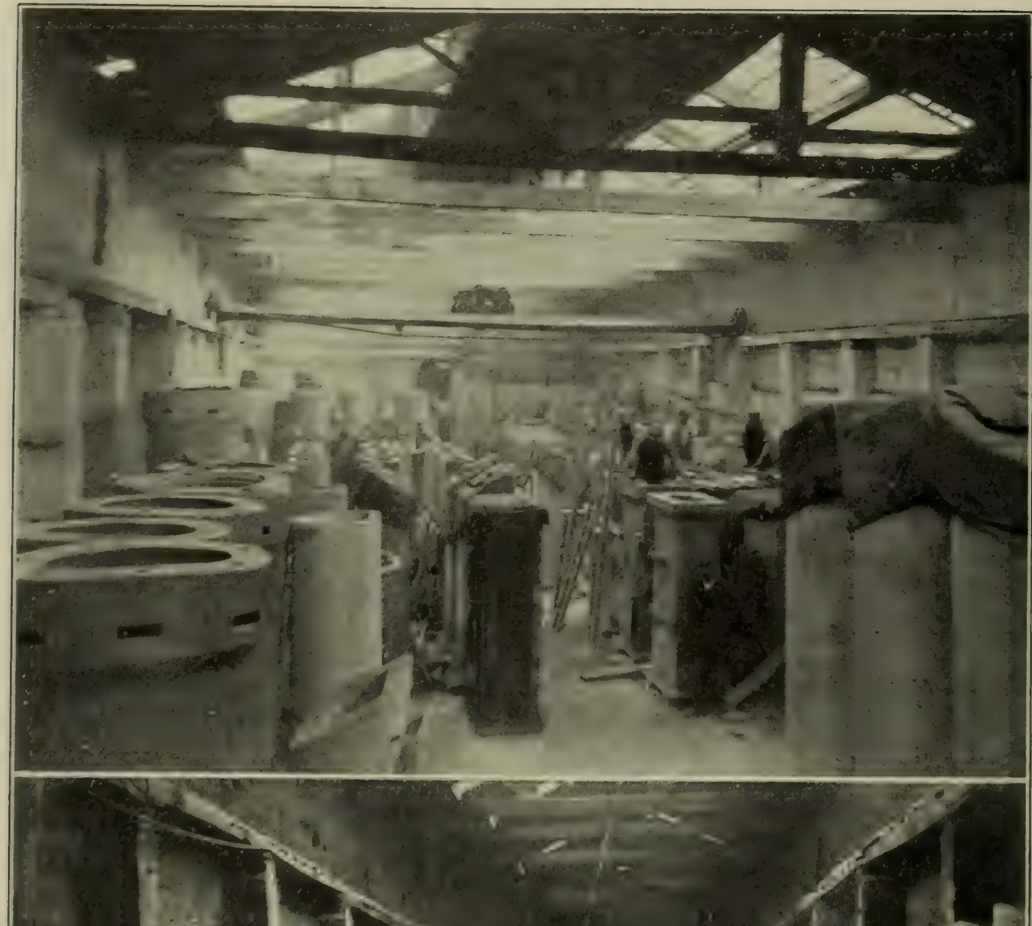
THE MANUFACTURE OF FIRECLAY PRODUCTS AT THE CINDER HILLS FIRECLAY WORKS. Three views in the drying sheds, showing the moulding of bricks by hand.

Most of the impurities are removed by weathering before the clay enters into brick form. This clay is usually mined at a depth of a little more than 85 feet, and it has to be blasted, which means that precautions have to be taken in the mine for storing powder, the arrangement being generally to build an arched roof and fire-brick sidewalls underground, closing one end with a fireproof door, the other being blank.

The seams vary in thickness from 8 to 12 feet, and the roof is generally slate with sometimes a poor grade of coal perhaps 6 to 18 inches thick.

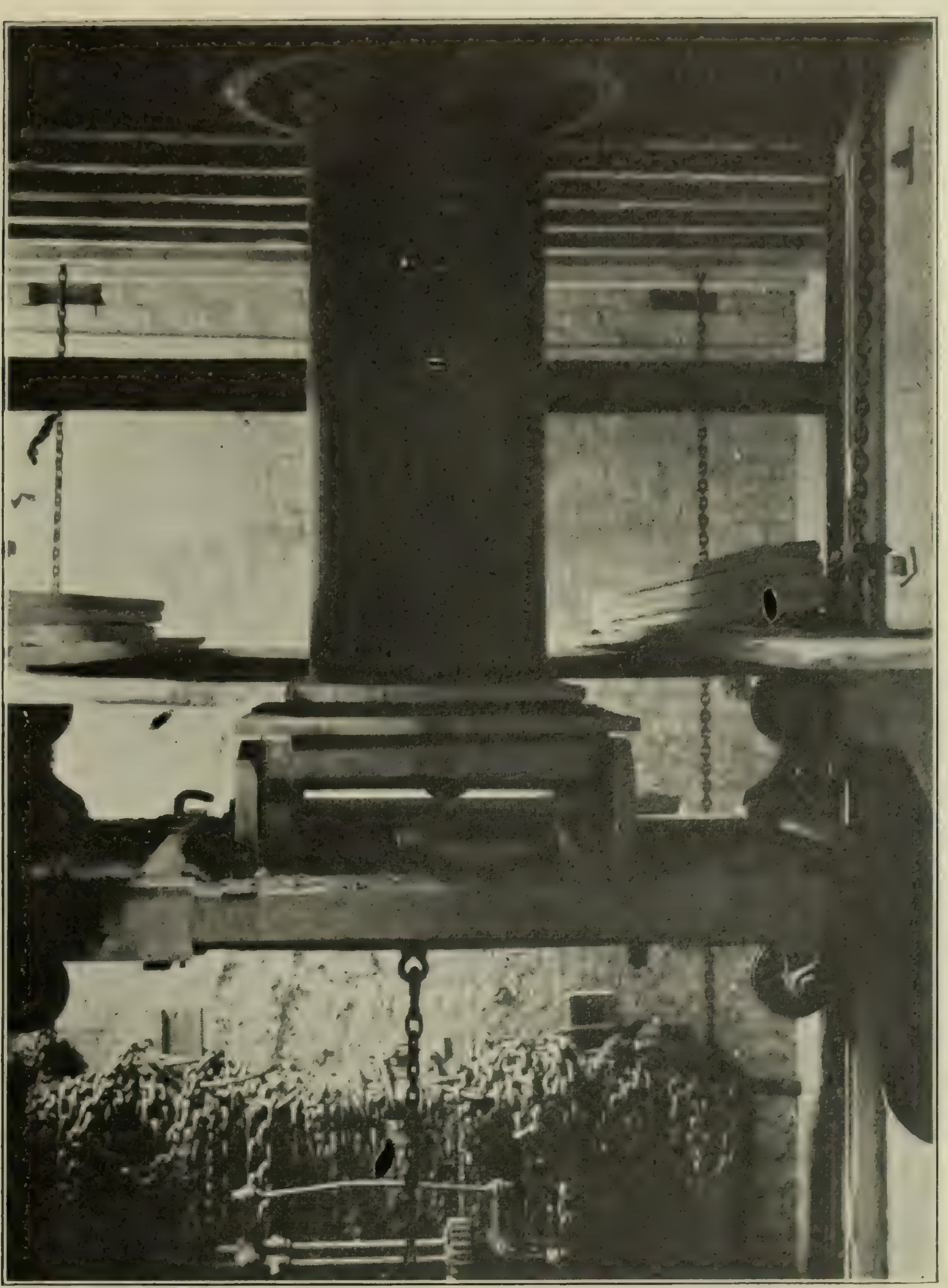
In arranging to "win" or mine the clay, several methods are adopted. The correct way is to employ competent surveyors and transit men, who lay out the work on paper and by stakes, so that not only is the clay gotten out to the best advantage, but an accurate record is kept of all cleared portions. The mine is laid out in what are called "entries" and "crosscuts." Timber has to be employed to preserve the passage-way and make it safe for working. When a crosscut is made, the miners are then set to dig out what is called a "room," this being the clay portion between two crosscuts, and measuring about 60 feet square. After the clay is taken out a distancet of 10 feet, timber props are put in to hold up the roof temporarily, and it is somewhat fearsome to a stranger to hear these props creaking as the roof settles. In some places this settling takes place quickly. It is not uncommon to see the props sinking into the undersoil when this is soft. If it is hard, the props will mushroom, top and bottom, or bulge and gradually splinter, and by that time there is no further need to hold the roof up. The clay thus dug out is picked, more or less, underground, the selected portions consisting of pot clay, (a plastic clay covered with a "roof" of poorer clay) being placed in different tubs. These tubs are then hauled underground by mules, driven by a boy who occupies an insecure position on a chain between two tubs, his body being sideways to the travel of the wagon tubs, and his foothold on the connecting chains. The mules maintain a fast trot through the aisles, which are comparatively dark.

The tub wagons are elevated from the mine in a balanced cage, and on reaching the surface, part of them are sent to the weathering bank and then to the factory for the manufacture of cheaper class of brick. The best clay is taken by the wagons and dumped by a jib crane into bins, from which it gravitates into large wagons which in turn take it to the weathering bank or a special calcining kiln.



THE RETORT SHEDS, CINDER HILLS FIRECLAY WORKS.

Two views in the drying sheds, showing horizontal, inclined, and vertical retorts in process of manufacture.



A RETORT MACHINE, SHOWING A RETORT IN PROCESS OF MAKING. CINDER HILLS FIRECLAY WORKS.

For the very best work the "pot" clay is picked by hand before going to the bins.

Other grades of clay are mined in similar ways to those described herein; but flint clay, which is of the highest quality, although sometimes found at the bottom of the plastic clay seams, in most cases is found near the surface in a different district. A few of the Missouri flint-clay mines have outcrops, and in other cases about 6 feet of top soil has to be removed. Holes are drilled and a blast is made, after which the clay is removed. It is very refractory and is most suitable for high heats where there is not much abrasion. For instance, it is not suitable for the lower part of a furnace, where clinkering tools are in use, as it is not tough enough to withstand this severe work; and flint clay becomes semi-plastic under high heats if subjected to pressure. Any attempt to make a denser or tougher brick, by adding a foreign element to act as a bond for the flint-clay particles, seems to destroy the character of the clay. Part of the raw flint clay is placed in a special calcining furnace (shown in one of the photographs), and it is most interesting to examine the partly burned raw clay after it is removed from the furnace or kiln. It very much resembles pop-corn, which name is sometimes applied to it.

The crude flint clay shows the following chemical analysis in some of the best mines:

Water	13.98	per cent
Silica	44.75	"
Alumina	36.37	"
Fe. Oxide	1.12	"
Lime	.00	"
MgO	.07	"
Alkalies	3.71	"

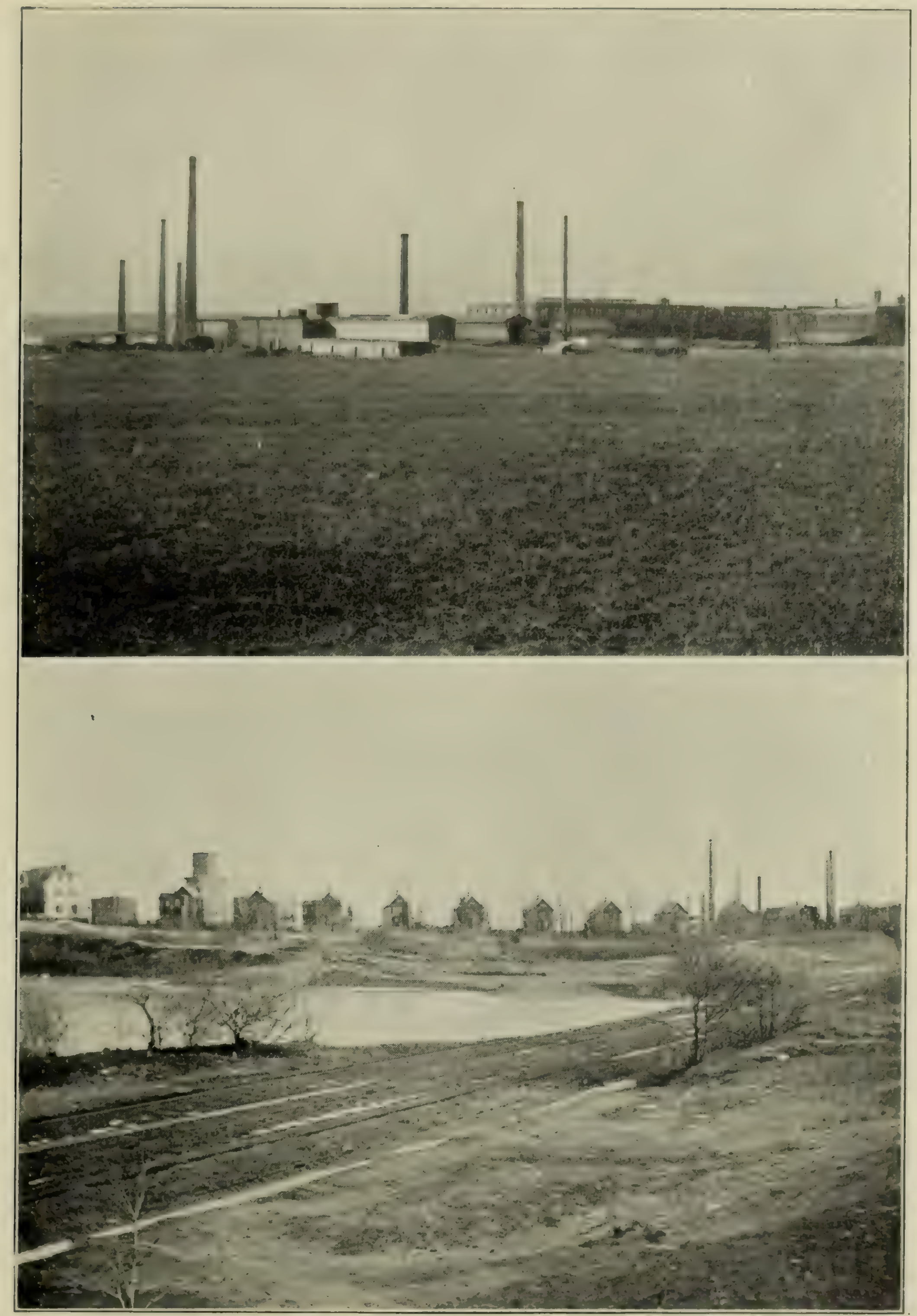
All the impurities are removed in the calcining process.

There is another very high-grade clay obtained from the Missouri mines and used mostly for the best glass-works practice, hence the name, "pot clay." It has the following chemical analysis in its crude unpicked state:

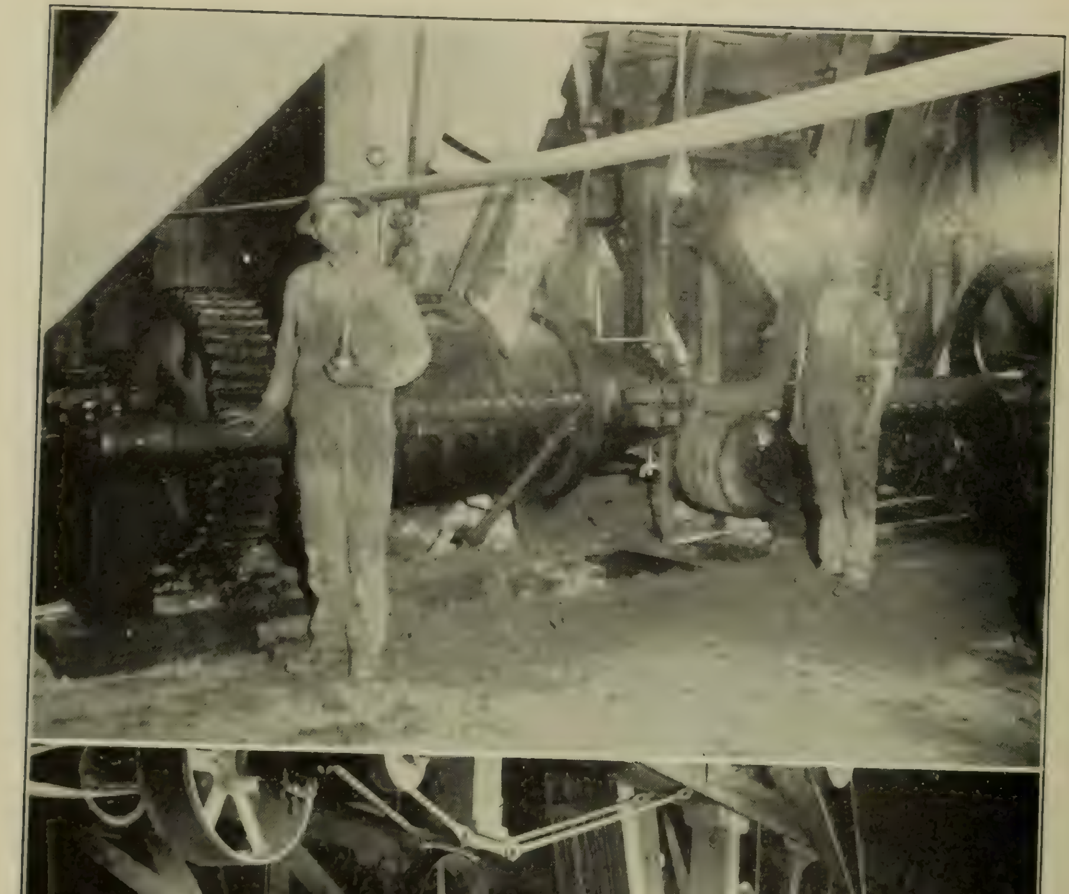
Water	11.02	per cent
Silica	57.53	"
Alumina	28.60	"
Fe. Oxide	1.74	"
Lime	.00	"
MgO	.54	"
Alkalies	.57	"

It is a plastic clay, similar to the Cheltenham, but of much higher grade.

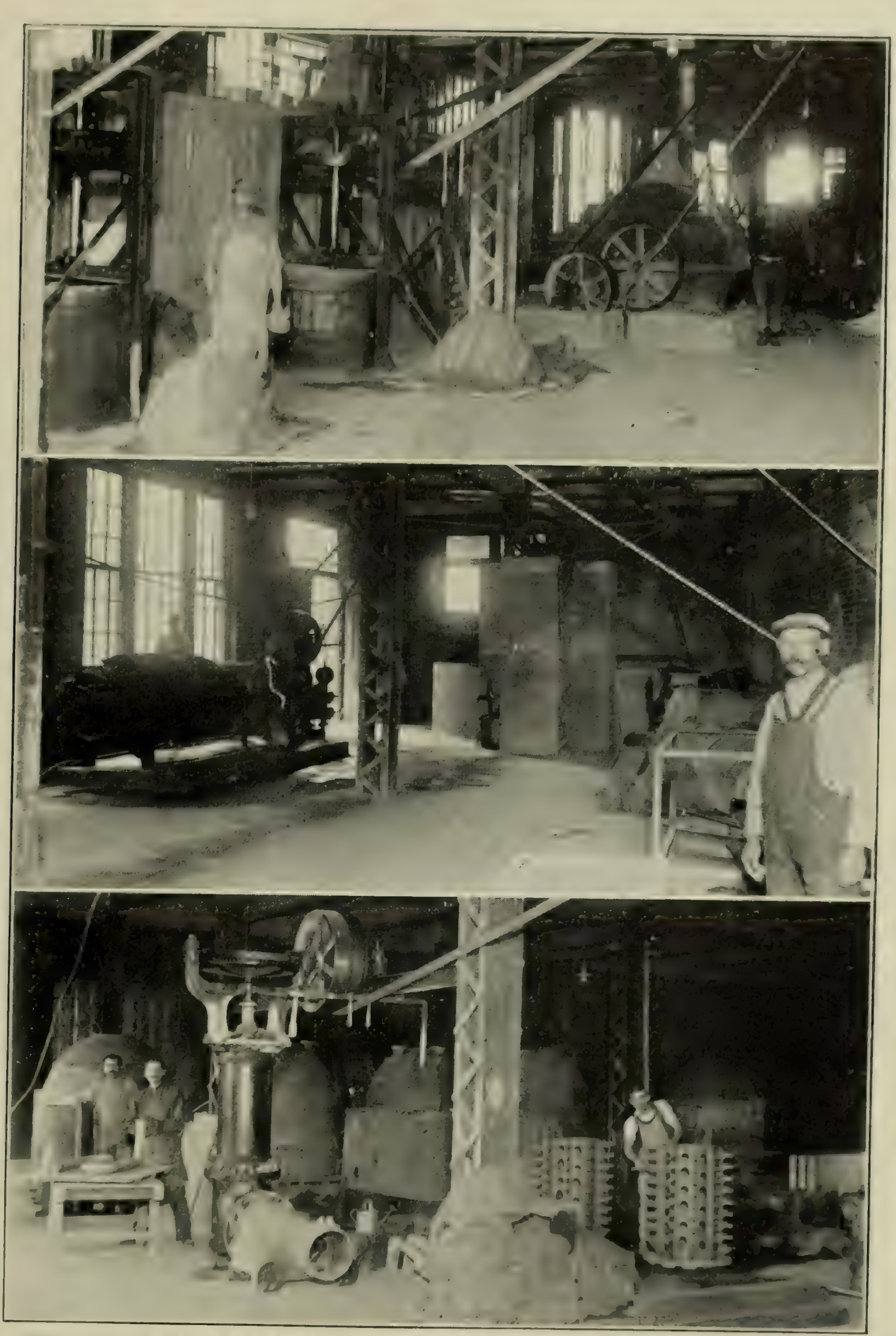
To give some idea of the machinery required in a clay works, we may say a plant making about 700 tons of shapes equivalent to 200,000 9-inch brick a day needs about 650 horse power to run the various machines. A usual arrangement on a works of this size is four dry pans, four wet pans, a cracker, and a Blake crusher. All



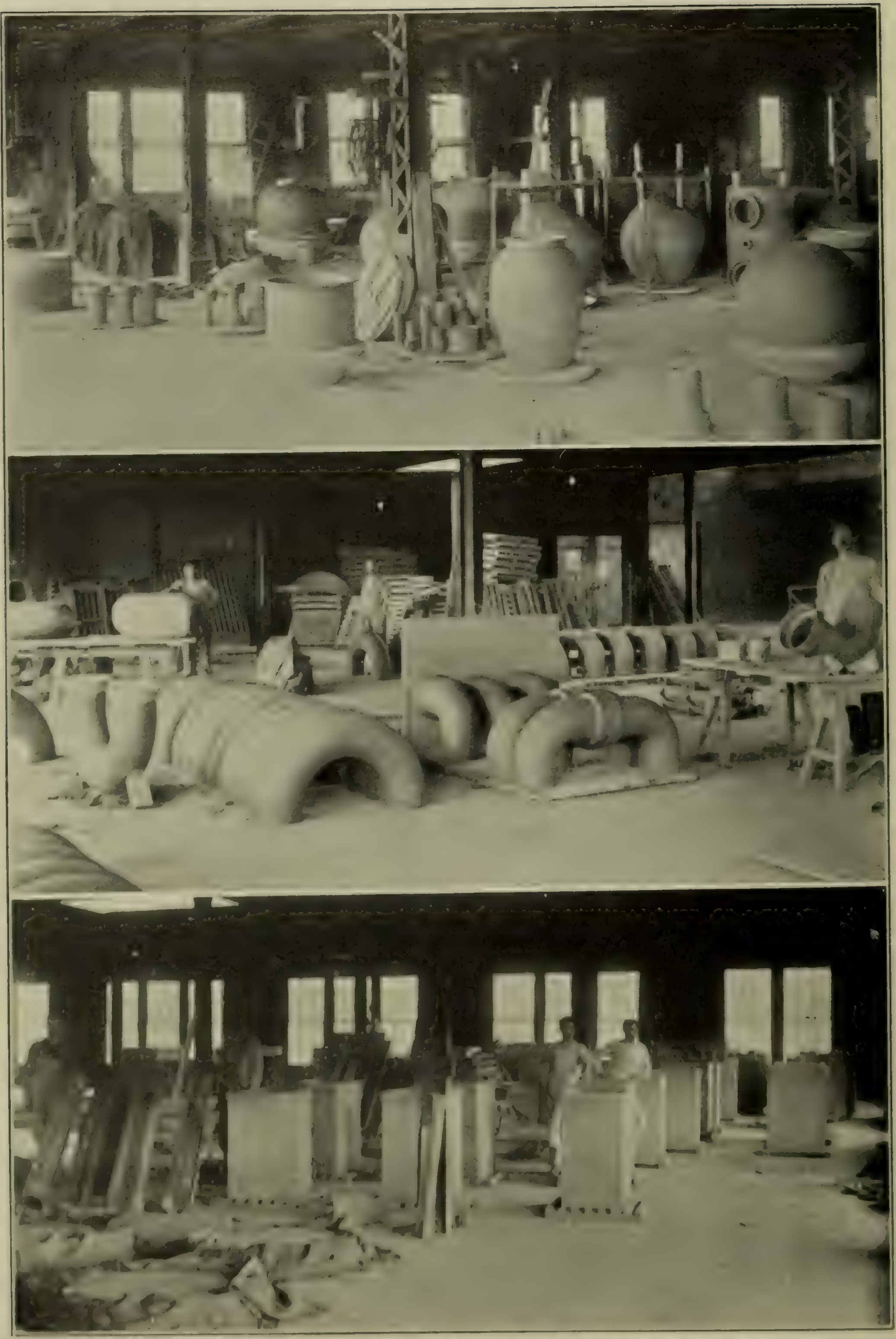
ABOVE, FIREBRICK AND STONEWARE DEPARTMENTS, KEASBEY WORKS OF THE DIDIER-MARCH COMPANY, NEAR PERTH AMBOY, NEW JERSEY. BELOW, THEIR COTTAGES AND INDUSTRIAL SETTLEMENT.



BRICK MAKING AT THE KEASBEY WORKS OF THE DIDIER-MARCH COMPANY.
Above, brick machine and bar of clay issuing from the die. Below, cutting bricks and transporting them to the steam repress. Thence they are taken to the waste-heat dryer for thorough drying before calcination in the kilns.



PROCESSES IN THE MANUFACTURE OF REFRACTORIES AT THE KEASBEY WORKS. The upper two pictures show portions of the clay-preparing rooms. The bottom one is a corner of the stoneware building, where complicated coils for acid condensation are made.



VARIOUS DEPARTMENTS OF THE KEASBEY WORKS, AND THEIR PRODUCT.
At the top, the manufacture of small apparatus: jars, receivers, etc.; in the middle, the manufacture of pipes and bends; at the bottom, the tank room.

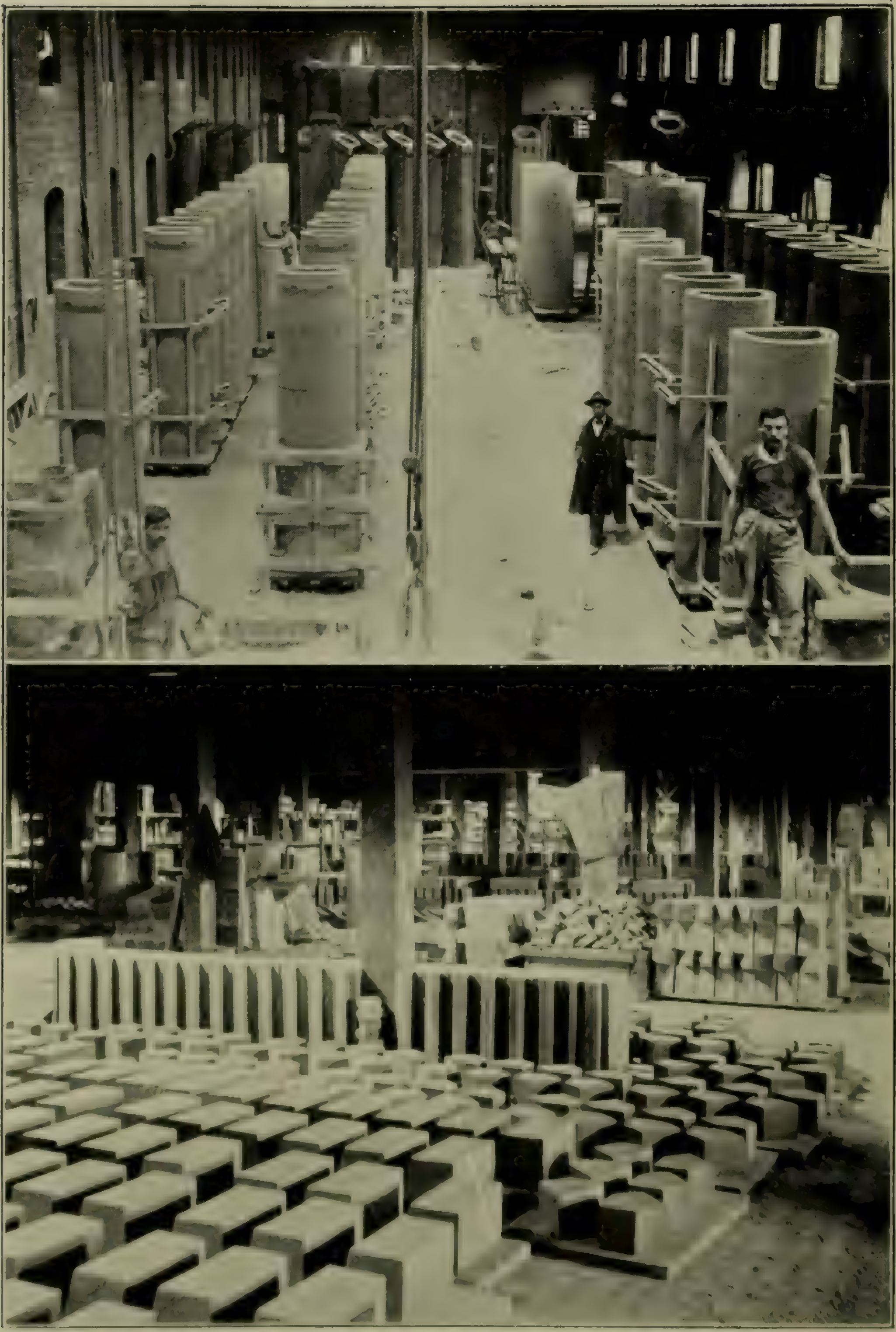
the clay from each dry pan is elevated in continuous buckets to the sixth floor, where it passes over very elaborate and effective traveling screens, the fine material dropping to the fourth floor and the rejected pieces passing back to the pan mill. The screenings fall onto one of two belt conveyors and are dumped automatically into large storage bins, situated over the wet pans. The mixed grades, of which there are about eight, pass through to the wet pans. For high-grade hand-made work the wet clay is taken by trucks on an elevator to any of the four operating floors where it is dumped on tables adjacent to the molding boxes.

Wherever possible it is advisable to use brick instead of tiles or blocks, but in erecting them only hammered work should be allowed. Thick joints cause more than 50 per cent of the failures in furnaces.

All tiles are thrown into molds by hand. It is not difficult to make necessary allowances in the molds to take up shrinkage of clay in air-drying and burning, so long as tiles are flat or of simple shape and have only one average thickness; but it is almost impossible to make blocks (other than flat or simple ones) so that a maker can guarantee the finished article to be like the blue-print. Having the desire to make the blocks accurate in shape and measurement, the maker never burns them in the kiln at high enough temperature or over a sufficiently long time. The consequence is a green core. If the blocks are hard burned, they twist and lose their shape, and even then there is a core which has not had all the shrinkage taken out of it.

In making bricks, part of the mixed grog and clay is sent through the wet pans and on to an auger machine which squeezes out a solid mass of plastic clay 9 inches by 4½ inches wide. It then goes on a band conveyor over a machine where a most ingenious contrivance cuts off about twenty brick at one time, while the clay is passing through it. The brick shapes, in somewhat rough form, are then removed by a band conveyor running in front of a dozen brick "re-presses," and four tile-making machines.

After coming from the re-press machine, the bricks are loaded onto cars which travel on rails along in front of the machines, and by means of turntables the cars are transferred to rails running through the brick tunnel dryers. These dryers are built of concrete and firebrick, in stacks of four flues each, and there are five stacks each 150 feet long. The heat is furnished from the kilns, where by means of dampers the hot air is diverted to tunnels and forced into the twenty dryers. An exhaust fan with a variable speed draws



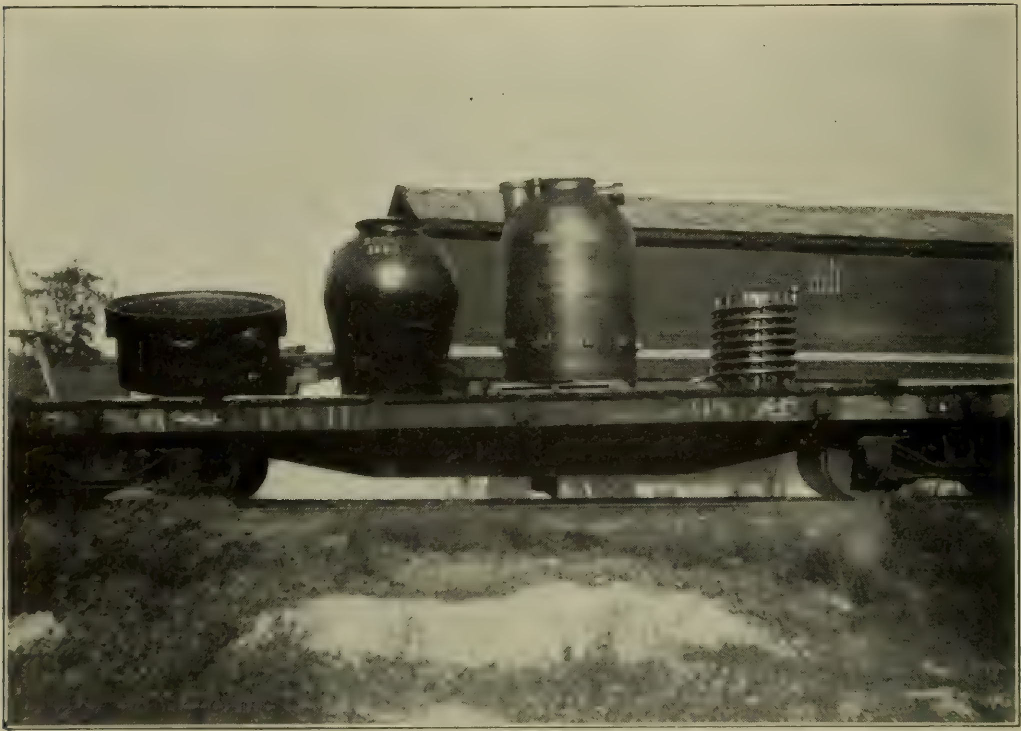
RETORT SHOP AND A PORTION OF THE MOULDING ROOM, KEASBEY WORKS.
The retorts, above, are for horizontal, vertical and inclined coal-carbonizing benches, some very long inclined retorts being seen at the extreme back. The intricate shapes moulded by hand are suggested by the lower view.

away the hot air as desired, in order to maintain equal and sufficient temperature. No heat is taken from the kilns which are under coal fire, consequently the heating medium for the dryers is always clean and free from sulphur or other deleterious chemicals. The tunnel dryers end towards the kilns, and from there the bricks are stacked ready for burning, which takes about a week altogether. All this work is done by hand labor.

Tiles and blocks cannot be hardened in the tunnel dryers. It is a fine art to "bone-dry" some kinds of tiles without cracking and distorting them, and a very thorough system of inspection must be arranged in a clay works where there may be at times all classes, thicknesses and shapes of tiles covering drying floors averaging 142,000 square feet. These tiles, especially those with holes in the body, and particularly where the corners are square, will crack very easily, generally at the corners. It is necessary to patch around the corners at times with loose damp clay. At other times wet cloths are spread over them.

Some tiles are designed by furnace builders in shapes that cannot be placed on the floor in such a position that their own weight will not collapse them. Sometimes ten blocks are made up so as to try and be sure of one good one. It is not unusual out of ten or so to get only five safely into the kiln, and then in burning four more are wasted. It is easy to figure out that such waste is very expensive, as all the labor and coal for ten tiles is expended, and only one tile or block obtained fit for use. These causes are responsible for expense in making tiles. They show why it is difficult to make tiles at any price, and indicate how advisable it is to cut out the tiles and use brick wherever possible. If a block or tile were better when finally put in use, there might be some excuse for adopting it instead of brick. Actually the reverse is the case, so there is all the more need for wonder that some people prefer the block and tile design to the brick. Bricks cost about $5 per ton. Tile costs $9 to $18. Brick can be set up cheaper. They are more reliable. We can only surmise that blocks are so extensively used because they look well on paper. It must be understood that tiles or blocks of even thickness, simple shape, and approximately brick shape and size, are easily made.

The photographs accompanying this article are representative of three large establishments, one British, one characteristic of the Western United States, and one near the American Atlantic seaboard, but of German parentage.



THREE OF THE LARGEST MONOLITHIC PIECES OF CHEMICAL STONEWARE EVER ATTEMPTED IN AMERICA.

Ready for shipment from the Keasbey Works of the Didier-March Company.

The British establishment is that of Joseph Morton, Ltd., Cinder Hills Fire Clay Works, Halifax, turning out a diversified product, including gas retorts, furnace linings, boiler seatings, blocks and tiles, silica bricks, and special forms. The second named, the works of Evens & Howard, are situated at Clayton, about ten miles from St. Louis. The capacity of their No. 3 plant is 200,000 brick a day; their No. 2 plant has a capacity of about 150,000 brick a day, but handles chiefly special work including gas retorts, chrome and magnesite brick, sewer pipe, etc. The third plant illustrated is the Keasbey plant of the Didier-March Co., near Perth Amboy, N. J. It is typical of the few establishments referred to above as being carried on by strictly scientific methods. Its two distinct departments are engaged respectively with refractory clay products and chemical stoneware. The former, which is most closely related to the present topic, comprises many branches of manufacture, from common brick to the most intricate blocks and special shapes. The laboratory in this plant performs a most important function in the process of manufacture.

METAL-WORKING PLANTS AND THEIR MACHINE-TOOL EQUIPMENT.

By Charles Day.

II. BUILDINGS FOR HEAVY AND GENERAL MACHINE WORK.

In two articles under this title, the first of which appeared last month, Mr. Day analyzes the machine-tool equipment of metal-working plants—not in detail, but in general character as influencing especially the design, layout and structural features of the buildings. The first part covered the general classification and the characteristics of general metal-manufacturing establishment. The present section considers heavy and general machine-tool shops. Mr. Day's general classification of metal-working plants into these three classes will be found on page 365 of THE ENGINEERING MAGAZINE for June, 1910.—THE EDITORS.

HAVING covered the principal requirements imposed by metal-working businesses that can be conducted upon a manufacturing basis, we will proceed to consider in the same manner the second class of shops, viz.: those that build given lines of reasonably heavy machinery.

M (2) a—MATERIALS—Usually comparatively heavy, quite diversified and bulky, so making the solution of handling and storing methods more difficult than for shops in the first class, although reasonably fixed conditions are presented.

The stores departments of certain concerns whose output would rightly fall in this class can be laid out with very great precision, because of the accuracy of their knowledge concerning the quantities of materials that should be available. There are other cases where no attempt is made to carry a considerable supply of finished product. The raw materials with which we are now more particularly concerned tend toward large and bulky parts, requiring for their handling and transportation special provision in the form of equipment, and often building features. It was pointed out that for plants coming within the first group the materials entering into the manufacture usually do not influence in any way the buildings proper. In this case, however, we find that the nature of the materials may necessitate floors designed for extraordinary loads, larger door and elevator openings than would ordinarily be required, owing to the nature of the materials, etc.

M (2) b—EQUIPMENT—Generally stock machine tools, adapted to a considerable range of work as compared with the wholly special equipment characteristic of the first class.

The class of work now in question is not sufficiently repetitive to justify the expense of special equipment, so the machine tools that are usually needed are the familiar types of engine lathes, boring mills, planers, drill presses, etc. They are designed particularly with a view to handling a diversified line of work, although the tendency within recent years has been more and more to narrow down their range. Each type is suited to the performance of certain operations, which may be required in connection with the machining of a great multiplicity of different parts entering into products used for widely diversified purposes. Therefore, this group of metal-working plants affords the engineer considerable opportunity for the performance of valuable service in connection with the selection of machine tools. This is the case because the problem is one of *selecting* the standard machines best suited to the performance of the various kinds of work, considered individually and collectively, rather than the task of designing special machines or auxiliary equipment for special operations which is presented by shops of the first class. The engineer who has had the necessary experience can perform the first function quite promptly, whereas the designing of special apparatus, even when the work is performed by experts, almost always requires an amount of time that is not available when planning a new shop.

M (2) c—BUILDINGS—Special to suit the size of the work performed in them and incorporating structural features that are used in the same sense as equipment.

The buildings for plants coming within the class in question must, as a rule, be designed with a view to meeting the special requirements imposed by the product. Overhead traveling cranes are often necessary, and insofar as the building structures are used to support the crane runways, etc., they contribute directly to the equipment of the plant. High head room is usually required under traveling cranes in order to allow of the erection of large machinery, and the heavy floor loads imposed, even in the machine departments, often necessitate special provision.

M (2) d—LABOR—A predominating part properly experienced in respective trades, not merely skilled in the attendance of machines performing single operations.

As stock machine tools adapted to a considerable range of work are used in plants doing the kind of work that we have under consideration, it is necessary to employ comparatively highly skilled operators. The fewer the parts that are handled, and in general the greater their bulk and weight, the higher must be the grade of the operators—assuming, of course, that a considerable amount of machine or other kind of work must be done upon the parts. Therefore, in shops where large steam engines are made we find that the average competency of the various workers ranks much higher than is the case in a plant making typewriters, although the intricacy of the latter product is much greater than that of the former. While this question of the character of the labor may not materially affect the physical features of the plant, yet it is one that must be thoroughly appreciated in planning a new property or an extension to an existing property.

M (2) e—ADMINISTRATION—Conditions as to materials and equipment and functions of employees are not capable of standardization in the sense that is practicable in shops of the first class, so that intelligent direction of the work requires the constant application of scientific methods based upon elemental understanding of all factors involved and applied through carefully devised system.

When complex conditions are encountered in connection with the planning of an industrial plant, it is certain that equally complex problems will arise in connection with the administration of the work to be performed when the plant is finished.

Owing to the fact that the greater part of the equipment is suited to the performance of a considerable range of work, and also because the number of parts of a given kind may be comparatively limited, it is frequently necessary to perform certain operations on quite a number of different pieces upon the same machines. For example, there may be forty or fifty parts entering into a complete engine lathe that require turning operations. Possibly at least 50 per cent of these parts should be turned upon engine lathes of the same size and type, yet a very small number of these lathes would be sufficient for the entire diversified output. Here we find a state of affairs quite different from that presented by the first class of shops, where a majority of the machines are operated continually upon identically the same work.

As machines are not automatic, there are usually a number of different methods by which given operations can be performed, but only one of these represents maximum economy. Different kinds of work present variations in materials, diameters, and amount of material to be removed, so that speeds and feeds must be adjusted to the particular requirements; and as continuous operation is seldom possible, it is necessary to make these adjustments very frequently. In fact, changes in speeds and feeds and changes of cutting tools are often necessary for the performance of a single job. Consequently, the efficiency with which machines operate depends upon the degree to which conditions representing maximum economy are maintained.

The various operations upon different parts of the product do not necessarily have to be performed in a given sequence, although one sequence represents maximum economy. From the standpoint of the arrangement of the equipment to accord with the most desirable plan of routing, it is clear that it becomes imperative to establish the sequence in which the more important operations should be performed. Usually there are conditions, arising either from the character of the equipment that is available or the work to be done, making one schedule of operations more desirable than all others.

In view of the foregoing, it follows that the amount and arrangement of equipment must be based upon the assumption that a certain definite system of operation is to be enforced. It is not sufficient for the engineer to decide merely that the operations shall be performed in a certain sequence and the machines always adjusted for conditions representing maximum output, for he may be basing his layout upon a system of shop management that the personnel will be wholly incapable of enforcing. The question of shop management is so extremely subtle and comprehensive that it is not usually practicable for the engineer to attempt to bring about radical changes in the methods employed by those for whom he is designing a new plant, unless the requisite time is available and the engineer's principals have a thorough realization of just what the work is likely to involve.

There are, of course, certain details that are affected directly by the system of shop management that is adopted—for example, the character and location of shop offices, entrances and exits for employees, etc. In addition to providing for such matters, the engineer should aim to lay out the plant so that it will lend itself efficiently to the system of administration he approves even though the older methods must be continued for some time.

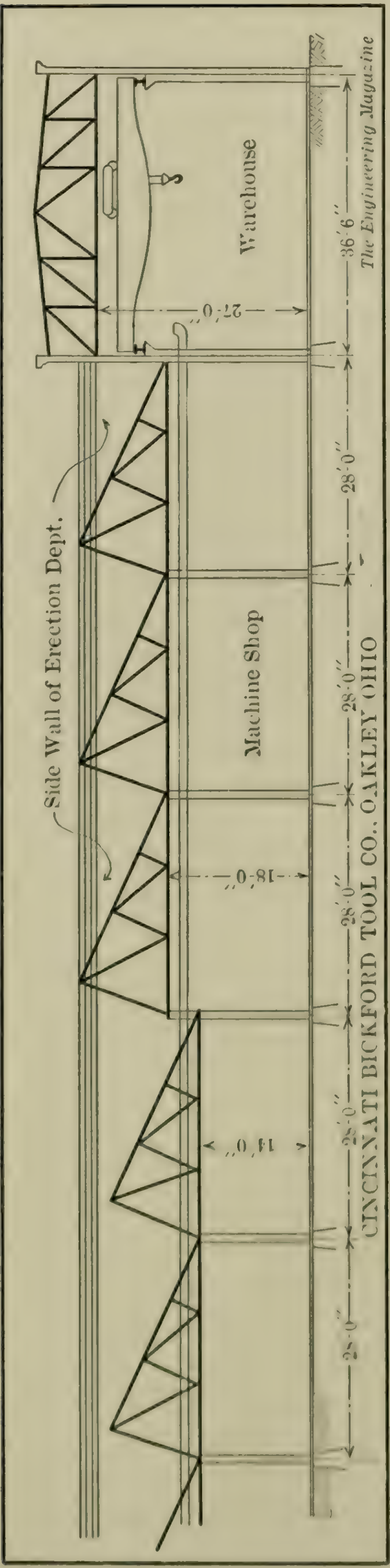
The problem of laying out plants coming within this group is much more subtle than in plants of the manufacturing type. The provision of buildings and equipment, worked out in accordance with certain fixed assumptions, does not assure, during subsequent operation, the fulfillment of these assumptions because the physical layout does not indicate necessarily the desired plan of routing. It will lend itself to many less efficint but workable alternate plans, and the same is even more true of the performance of individual machines. It is particularly important that this condition should be recognized by those who will operate the property. It is an inherent fact that while such a layout as we are considering should prove, in the hands of experienced men familiar with its purpose, to be fully as efficient as anticipated, in the hands of others it will probably fall far short of the requirements.

M (2) A, B, C, D, E—RÉSUMÉ.

Owing to the great number of variable factors entering into the problem of laying out plants for heavy machine work of a given line, requiring, among other things, the establishment of certain assumptions concerning the manner in which the work will be handled after the plant is built, it is evident that the selection of equipment both as to character and amount cannot be accomplished with anything like the certainty that is possible for the manufacturing plant. Further, the character of the building is directly dependent upon conclusions reached concerning the equipment, and as these very conclusions are, to a certain extent, only an approximation, it will be seen that unless the best of judgment is exercised, the most favorable solution in regard to the buildings proper will not be obtained.

The routing problem in shops of the second class is much more difficult of solution than in the first instance, and it is much more difficult to comply with the adopted plan than for manufacturing plants. In the first place, when laying out the shop, one cannot expect to secure uniform progress of materials through the plant and the result must necessarily be a compromise with a view to securing the best average routing of all the parts. In certain cases, it becomes necessary to consider carefully the advisability of installing additional equipment, rather than transporting the parts a considerable distance to points where equipment of the desired character is available. In such instances the handling cost must be weighed against the interest and depreciation charges incurred through installing additional machinery for convenience only.

A re-arrangement of departments for the purpose of increasing deficient areas or changing the plan of routing can be effected quite readily, as a rule, in a manufacturing plant where the buildings are of uniform cross section and the equipment can be readily moved. Re-arrangements of this kind, however, cannot be made with anything like the same facility or efficiency in the plant composed of various buildings designed for specific kinds of work. Therefore, we are confronted with the anomalous condition that for plants in which the requirements can be definitely anticipated, subsequent changes in departmental locations and areas are not likely to be necessary, although



CINCINNATI BICKFORD TOOL CO., OAKLEY OHIO

A TYPICAL CONSTRUCTION FOR A PLANT DEVOTED TO MODERATELY HEAVY SPECIAL MACHINE WORK.

A high bay for the warehouse department, one perpendicular to it for erecting large equipment, and large saw-tooth roofed area for machining departments.

they can readily be made; whereas for plants in which the requirements cannot be so definitely ascertained, and the need of subsequent changes is thus more probable, the buildings must be specially designed to comply with radically different kinds of work, which, of course, makes a re-arrangement very difficult to accomplish.

The buildings illustrated on pages 540, 541, 542 and (in part) 546 are occupied by kinds of work that come within the second division of the classification, and it will be clear at once that the designs of the structures have been directly influenced by the character of work performed within them. Not only are the types of the various buildings quite different, but they also represent a wide range in cross-section dimensions. The total floor space provided in the shop of the Emerson Steam Pump Company, Alexandria, Va.,* is about equally divided between the area served by an electrically operated crane requiring a relatively high headroom, and an area or areas over which light cranes can be run but where the head room is such as to lend itself properly to the installation of overhead line shafting. The requirements imposed by the work performed in the machine and transformer departments of the Wagner Electric & Mfg. Company, St. Louis,* were such that the areas under the high bays needed to be only one-third of the total floor space, so that the conditions were fulfilled by designing gallery shops as illustrated by the cross-sections. In both these shops the gallery construction possesses industrial advantages in addition to requiring only two-thirds the amount of real estate that would be occupied if the shops were single story throughout.

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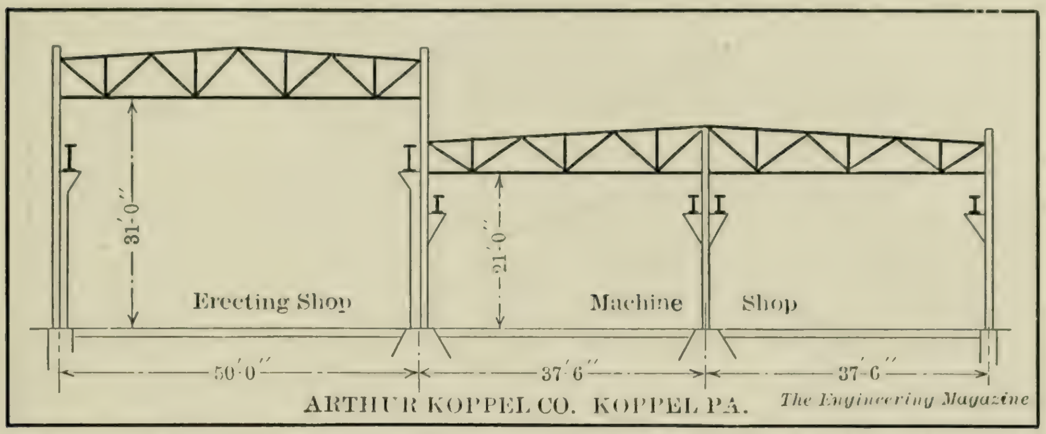
* These buildings are shown on page 546.



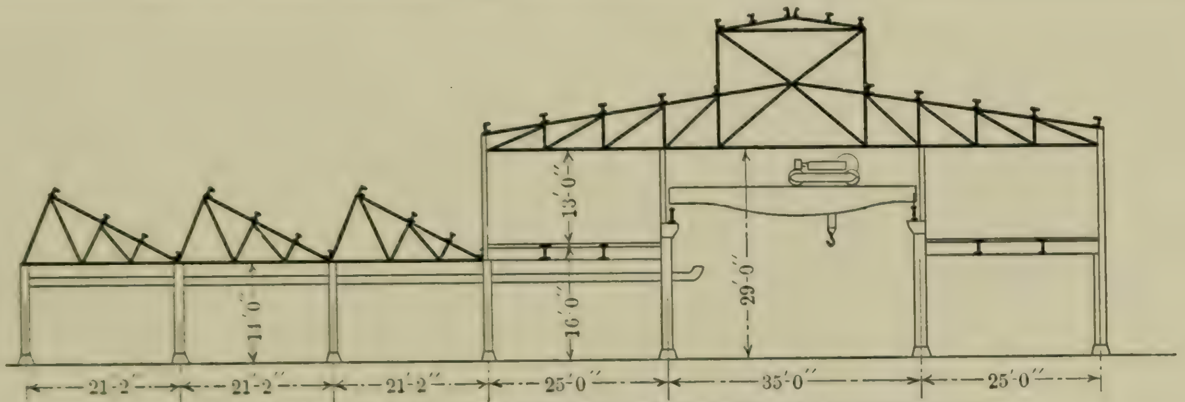
A MACHINE-SHOP FOR MANUFACTURE OF CONTRACTORS' DUMP CARS, INDUSTRIAL RAILWAYS, ETC. SPECIAL WORK OF MODERATELY HEAVY CHARACTER.

Frequently, the area in connection with which relatively high headroom is required is only a small part of the total necessary enclosed space. The main buildings of the new plant now being constructed for the Cincinnati-Bickford Tool Company, Oakley, Ohio, are shown in cross-section on page 540. It will be seen that a high bay is provided for the warehouse department, and one running perpendicular will house the large equipment. The machining departments will be housed in a large area covered by a saw-tooth roof construction, two distinct clear heights being provided to accommodate different kinds of work. A cross-section of two of the shops above, composing the plant of the Arthur Koppel Company, Koppel, Pa., illustrates the manner in which provision was made for the building of their output, which consists of contractors' dump cars, industrial railways, etc. The machine shop now being designed for Barnard & Leas Mfg. Company, Moline, Ill. (page 542) is another interesting illustration of the manner in which certain special requirements have been fulfilled, and the proposed boiler shop of the Ames Iron Works, Oswego, New York, is another.

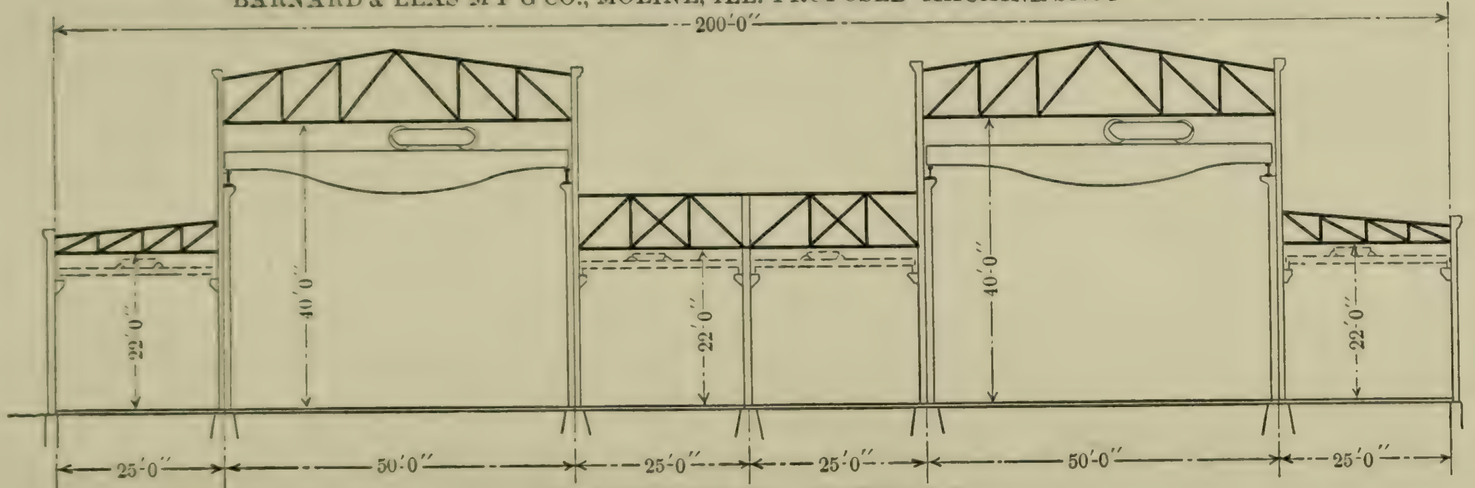
General Machine Work.

We will now take under consideration the broad requirements imposed by metal-working plants that compose the third division of our classification.

M (3) a—Materials—The character and amount of materials can be anticipated only in small part, owing to uncertainty of kind of work



BARNARD & LEAS M'F'G CO., MOLINE, ILL. PROPOSED MACHINE SHOP



AMES IRON WORKS., OSWEGO N.Y.
PROPOSED BOILER SHOP.

PLANTS ILLUSTRATIVE OF ADAPTATION TO SPECIAL REQUIREMENTS OF MODERATELY HEAVY MACHINERY BUILDING.

that will be done. Consequently, there is imposed a wide demand upon the receiving and stores departments.

The repair departments that must be operated by certain large industrial companies come within the group of plants now under consideration. The requirements that must be met in such cases are defined, of course, more clearly than is true for businesses that depend entirely upon jobbing work, but their administration is more difficult in one sense than in the latter case, because extraordinary demands upon the repair department are likely to develop when least expected. If the shop in question is the one set aside for making repairs upon the equipment of a large rolling mill, there will be performed certain routine work comprising the making of parts that must be regularly renewed, turning of new rolls, building of special auxiliary equipment, etc., but the department must also be so equipped and administered that it can handle expeditiously extraordinary repairs of practically any kind demanded by the business.

The raw-materials stores room for a shop of this kind usually contains two distinct classes of materials, namely, those provided for specific purposes such as duplicate machine parts, and various materials which can be used in connection with a variety of needs constituting the daily requirements of the shop. Each commission of this kind presents wholly special conditions, which it is quite impossible to define broadly with anything like the precision applying to the stores of manufacturing plants. In the latter instance the raw material is characterized by large quantities of comparatively small parts, for the storage of which very efficient means can be provided. In contrast with this condition, the materials that must be available in the stores room serving the repair shop are usually of the most diversified character. In certain cases, we find one, or at the most two or three, duplicate parts of very large size and weight, more duplicate parts of smaller size, and a comparatively complete line of miscellaneous supplies, there being, however, but a comparatively small stock of any one article or material. The large parts may absolutely necessitate the provision of special means for handling and transportation, but the bulk of the materials are such as can be handled readily without such assistance. When conditions are as outlined, the stores department can be laid out, however, with somewhat greater precision than is possible in connection with a shop that does purely jobbing work.

The very nature of the jobbing plant is such as to prohibit a close definition of either present or future requirements. The purpose in view is to prepare for as diversified a line of performance as is possible, but insofar as raw-material departments are concerned it is practicable to carry a permanent stock of only those materials that can be adapted to various uses. Provision must be made, however, for anticipated requirements imposed by the handling and temporary storing of the special materials that given orders are likely to cover.

M (3) b—Equipment—Principally stock machines suited to very wide range of work. Occasionally special machinery for possible repairs on special parts. Selection of types and determination of amount of equipment can be approximated only.

The ability to perform almost any conceivable job is usually the first requisite when selecting machinery. Therefore, the greater part of the equipment required for job and repair shops consists in standard machine tools, designed with a view to the performance of very wide ranges of work. If this plan is not followed a greater amount of equipment will have to be installed, part of which will stand idle a considerable portion of the time, thus imposing a heavy burden upon the business or department. Wide range of usefulness is usually accompanied by lower efficiency of performance, the efficiency being higher as the design of the machine aims towards singleness of purpose, and becoming a maximum in the full automatic types. However, it frequently pays to secure a wide range of usefulness even at the expense of efficiency, for the ability to perform a given job may be the vital factor, whereas the cost incurred may be secondary only. The lathe equipped with a two-spindle head stock and the boring mill that can be increased in capacity by movng the housings back are extreme examples. In actual practice many other procedures are of course resorted to for the purpose of accomplishing certain work, which procedures would not be considered good practice in plants of the second group. Instances are the use of a planer or slotter where a milling machine would do the work more cheaply, or the use of a milling machine in place of a gear cutter, or the performance by hand of certain operations that under other circumstances could be done more economically by machine. Consequently it is evident that the selection of machine-tool equipment for repair or jobbing shops is a matter in connection with which many questions other than efficiency of machinery must be taken into account.

Repair shops may impose more specific conditions, as for example in the case of a shop serving a large rolling mill, where it may be imperative to provide certain equipment that is designed particularly with a view to making repairs on large parts of the equipment, the breaking of which may be a remote possibility but so vital, if it does occur, that it is justifiable to have available at all times the means necessary to effect the repairs. Then, again, there is the equipment required to turn the rolls and do other single-purpose routine work.

M (3) c—BUILDINGS—The character of work to be done is usually a governing factor in their design. Precise definition of types and sizes is, however, seldom practicable.

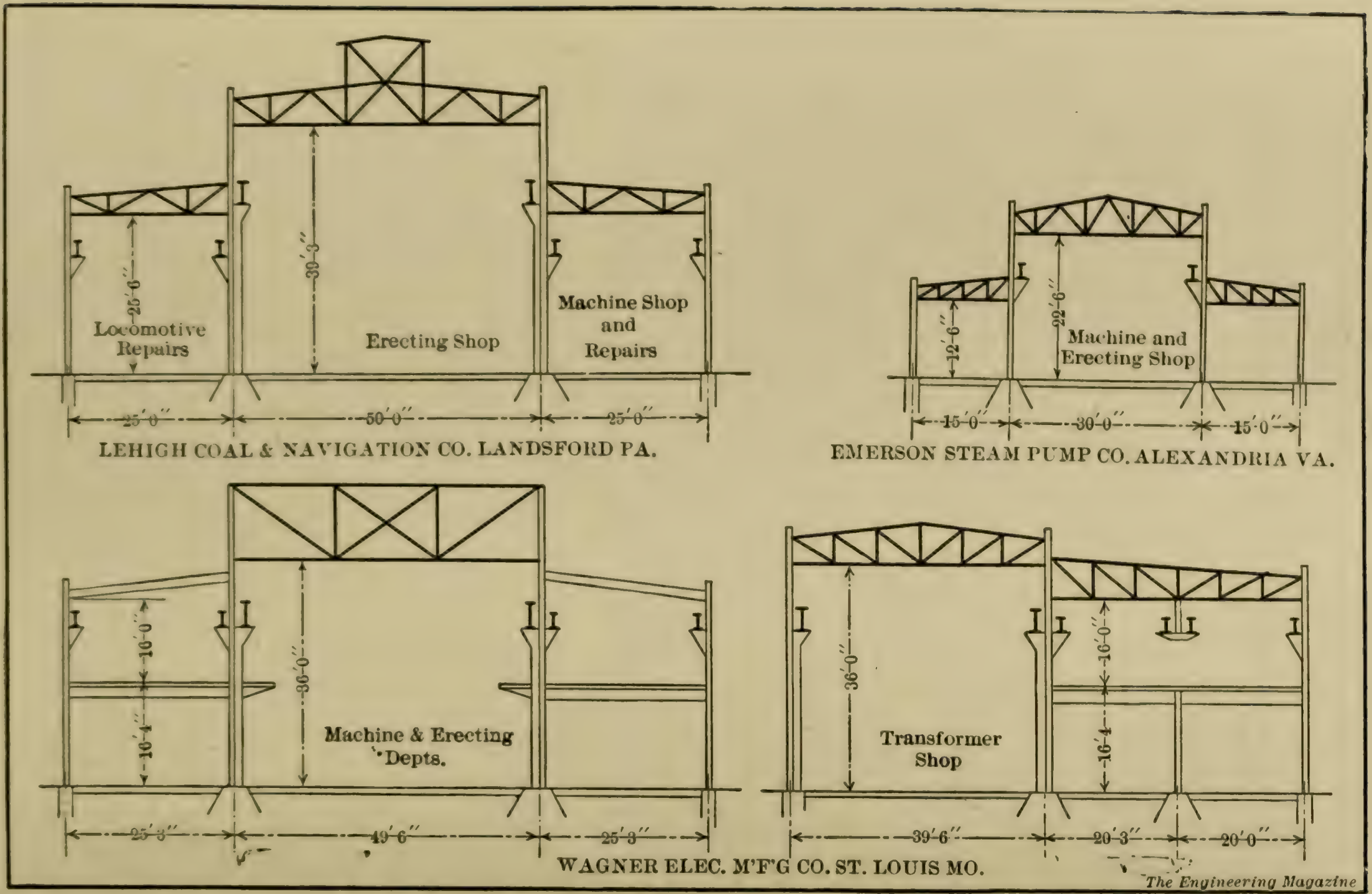
The buildings or sections of buildings required for repair or jobbing work differ widely in character, depending upon the characteristics of the work to be performed. However, their design is governed by broad conditions which affect principally overall dimensions in plan and elevation and also the floor loads. They have not the detailed peculiarities which are illustrated by the cross-sections of shops coming within the second group of our classification. The exception to this rule is presented by repair shops where definite requirements may be imposed by certain specific lines as previously referred to. As a rule, if the work that is to be handled is at all broad in its characteristics, there is required not only a section with considerable overhead room served by a traveling crane, but also an area with less overhead suitable for machine tools. Hence standard types of single or multiple-story buildings adapted to various classes of occupancy are not often adequate.

M (3) d—LABOR—Especially versatile in respective trades. Possibly not so capable at any one job as operators in shops of second class, but competent throughout a much wider range of performance.

The labor employed in repair or jobbing shops has the same broad characteristics as other factors that have been touched upon; namely, the various employees should be "all-around men" rather than specialists, and just as the all-around machine is not as efficient as the one designed for the performance of a specific job, so we cannot expect the versatile mechanic to attain as high an efficiency of performance as the specialist. The character of workmen required is a question that must be considered carefully by the engineer who is planning a new plant or extension, and also the status of the trades in question for the locality where the plant is to be built.

M (3) e—ADMINISTRATION—The system of management should be the one that will prove most effective under the circumstances that make it impossible to anticipate exact conditions from day to day. Each case must be worked out along special lines and often conditions are such as not to justify a highly perfected system.

The administration of all industrial plants should be based upon the same fundamental principles, irrespective of the nature of the work performed, but the details of the administrative system may differ materially for each of the three groups in our classification,



LEHIGH COAL & NAVIGATION CO. LANDSFORD PA.

EMERSON STEAM PUMP CO. ALEXANDRIA VA.

WAGNER ELEC. M'F'G CO. ST. LOUIS MO.

The Engineering Magazine

THE LEHIGH COAL & NAVIGATION SHOPS BELONG TO THE THIRD CLASS—REPAIR AND JOBBING WORK; THE OTHERS, TO THE SECOND CLASS, OF SPECIAL MACHINE SHOPS.

Note the dimensional difference between the Lehigh Coal & Navigation and the Emerson Steam Pump Shops. Note also division of areas for machine and transformer work and provision of galleries for the lighter operation in the Wagner shops.

and, in fact, must be varied for different plants coming within the same group.

The primary condition that must be dealt with in connection with a manufacturing plant is the one presented by an output made up of comparatively small articles turned out in large quantities and sold from stock; therefore, the work can be planned considerably in advance and with a very great degree of exactness. The repetitive nature of the work permits of the establishment of definite standards for the manufacture of the entire output, which standards when established are adhered to until the experimental departments have devised more efficient means.

Plants composing the second group possess the characteristics just referred to only in part. While all the output may be built in accordance with stock orders, the trade requirements are frequently such that it is not practicable to carry a very large number of duplicate units of the product. Standard methods of doing the work have to do more with the performance of detail operations than work upon the parts considered as a whole. The nature of the equipment employed must be such as to make it much more flexible, insofar as its uses are concerned, than is necessary in the manufacturing plant. Efficient performance requires, as a regular function of the administrative system, one or more specialists whose duties consist in the preparation of definite instructions covering the manner in which the various operations must be performed, taking into account the exact means that will be available.

The pronounced characteristics of the jobbing or repair shop are that it is practically impossible to plan the work as a whole for a considerable period in advance, nor is it possible to establish fixed methods of performing certain jobs of like character which may be received at odd intervals, as the necessity for completing such jobs in the least possible time may require somewhat different procedure in each case owing to the demands of other work that is being handled. Effective administration of shops comprising the group in question must necessarily be accomplished through a system permitting of very great flexibility, and there is required a degree of personal contact between the executive head and the shop superintendents that may not be desirable or practicable for plants in the first or second group. Each case must be worked out along special lines.

M (3) A, B, C, D, E—RÉSUMÉ.

It is obvious from the foregoing that plants for businesses or departments coming within this group can be laid out with the least precision, as compared with those composing the two groups formerly considered. The equipment must be selected with a view to a wide range of performance rather than to the manufacture or building of a certain output. This wide range of usefulness, rather than the attainment of high economy of single operating, is usually the ruling factor. Occasionally the need of certain definite work requires the installation of special machines. The type of buildings must be based upon certain broad requirements, and to the extent that large and heavy work is handled they are special is character. Administration methods must be suited to comparatively uncertain conditions, and while in one sense such conditions call for the most highly perfected system, there may be incidental reasons which prohibit or do not justify their introduction. In any case the system must be one which operates from day to day.

While the foregoing discussion regarding repair and jobbing shop is too general in character to be of direct value to the engineer who is engaged upon the planning of a given shop, yet he will find that the solution is more readily attained if he himself and those with whom he is co-operating have a correct realization of the limits of the problem as compared with those presented when planning shops for work that belongs to the first two groups.

The shop of the Lehigh Coal & Navigation Company, illustrated on page 546, was designed primarily to handle repair and jobbing work. One of the side bays is provided with a drop pit and an overhead traveling crane that are used in connection with the repairing of standard-gauge locomotives. The other side bay is used in part for machine work and in part for the repair of narrow-gauge locomotives of the steam and electric types. The main bay of the shop is occupied by the large electrically driven machine tools and the department for the performance of miscellaneous repair work upon pumps, engines and general mine equipment. There is also a certain amount of new machinery built in this shop.

As previously stated, it is usually found that the requirements presented by a given metal-working buisness do not fall wholly within the clear confines of any one of the three divisions comprising the classification, although in almost every case there is a predominating tendency toward one of them. If this happens to be the first division, a definite and clear-cut solution should be expected; if the second division, the solution will not be as clearly defined and the selection of equipment, its arrangement, and that of the departments, will represent but a compromise of the to some extent conflicting requirements imposed by the diversified kinds of work; if the third division, the solution is usually but an approximation as it must be worked out from comparatively meagre data.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

III. KEEPING DOWN SHOP EXPENSES.

Mr. Claydon's articles are not addressed to the highly organized and amply officered foundry characteristic of a few of the latest and most advanced establishments, but to the modest plant which needs to study carefully the outlay of every dollar and the sufficiency of the returns secured. His argument is that the very practical, common-sense and simple records he advocates will much more than repay the small cost needed to put them into effect. His first article, in May, was on "Finding the Actual Value Received for Each Dollar Expended." The second took up "the Handling of Stores and Prevention of Waste." A concluding paper in August will show how all the information collected by his system may be brought together and made effective for economy.—The Editors.

IN the two preceding articles that have appeared in this Magazine I have endeavored to point out the necessity of an employer's obtaining full value for his expenditure and at the same time knowing that he is doing so. We have also seen how imperative it is that the work performed by our employees should be correctly recorded and apportioned, and also that our materials should be under strict control and systematically handled. Even all this information, valuable as it undoubtedly is, will be of little service to us, unless full advantage is taken of proper means to remove the weak spots it will invariably show up. In short, it is not much use our finding out through these reports that our indirect labor is too high in the foundry, for a certain period, and then leaving the matter in the hope that it will right itself the following month. Points like this should be matters for serious consideration between the employer and the superintendent and foremen, and it is my purpose in this paper to deal with the various shop expenses and to endeavor to show that by a methodical way we can deal with these and obviate any undue expense in any or all of our shops.

First of all, then, it might be well for us to consider what a shop expense really is. In all works we are bound to have men who are neither directly nor indirectly connected with the manufacture of our staple products, yet at the same time their work is an essential factor, and consequently a burden on our whole output, usually apportioned as a percentage either on the direct labor or the good castings made. For instance, it is necessary from time to time that repairs be made to our buildings or machinery; these are some of our shop expenses. For the purpose of illustration we may divide our shop expenses into two main heads, viz.: those which have to be apportioned on the tonnage and those which are percentaged on direct labor. For instance, flask renewals, cupola upkeep, moulding supplies, these are all tonnage charges, for the reason that the greater the output the larger the quantity of these materials used, and also the greater labor expenditure in consequence. On the other hand, maintenance of machinery, buildings, and tools, are governed by the amount of direct labor expended on our output, and obviously must be apportioned as a percentage of the direct labor on each class of good castings produced. There has been a great deal of argument as to why the whole of our burden should not be apportioned on the basis of tonnage, i. e., the net pounds of salable product. The reason I would assign for not doing so is that the items which go to make up our shop burdens are of two kinds. First, there are the items which necessarily increase with our output, such as those previously indicated, whilst in the second place there are those elements which do not seem to be in any way governed by the quantity of castings manufactured, for example, maintenance of buildings and such like charges, which would therefore be more correctly distributed by percentage of direct labor expended on our various classes of castings.

It will be seen at a glance that these indirect expenses will ordinarily amount to no small sum in a month; hence the necessity of some sort of system whereby they may be controlled. As I have previously stated, if these expenses are allowed to go on without question as to their necessity, then we at once allow for a very big leakage in our production costs.

In a previous article I hinted at the fact that our metal pattern department may become our graveyard, and as it is a very important factor in our costs I propose to show how and where the leakages may exist. In the first place, I think it will be conceded that almost all our employees in this shop will be day-work men, and one knows from experience that the best results are not readily obtained from day workers; hence it is essential that we have a good reliable foreman at the head of this department who will hustle and see that he gets the best out of the men under his control. Moreover, it will be easily seen that in a department such as this a good deal of our work, in fact the major portion, will be shop expenses, as all renewals of patterns come under this heading, also metal flasks, etc.; and one knows from experience that the metal and tools used in connection with this work are no small item, to say nothing of the labor expended on them. Again, it often happens that the foundry has to call upon the machine shop to do repair work for it; and if track is not kept of the time spent by the men executing this work, the machine shop would have to stand the expense, which on the face of it is wrong. To offset such chances of error as this, and better still to give us a line on the numerous repairs that are going on in each department, we must in the first place classify our principal shop expenses, and this may be done in the following way:—

1.	Wages and Materials for Cupola (including Repairs)	Tonnage Charges.
2.	" " " " Moulding Supplies........	
3.	" " " " Renewals of Flasks......	
4.	" " " " Maintenance of Machinery and Tools.............	Direct Labor Charges.
5.	" " " " Maintenance of Buildings.	
6.	" " " " General Shop Expense...	

All of these, with the exception possibly of No. 6, are self-explanatory. With regard to No. 6, one might say that the purpose of this charge is to cover such incidental charges as cannot be put to any of those before mentioned. For example, a man whose duty it was to sweep up the shop would be charged to this expense, as also would brooms, waste, etc. In the event, then, of the foreman of the foundry requiring a repair to a moulding machine, it would be necessary for him to issue an order on the foreman of the machine shop to execute the same; further than this, in order that the work may be kept track of in the departments through which it is expedient for it to pass, copies of this order should be sent to the respective foremen, viz., foundry, cleaning shop, machine shop, and the timekeeper should also receive a copy. A form like that suggested on the opposite page might conveniently be used.

The back of this form should be divided into two parts, and the divisions headed "Labor" and "Material" respectively. As soon as the work called for in the order has been completed by the foundry, the foreman of the foundry should turn his copy of the order to the timekeeper, together with a report (written on the back) as to all labor and material expended by his department on this expense; the same process being gone through by the foreman of every shop through which this work passes. As soon as the timekeeper has received all these orders, as completed by the shops, he will make up the total cost of the work, and file the order; or place the final cost before the superintendent for his perusal. The advantages accruing from an order system like this are numerous. One can readily understand how useful such information as this will be to the superintendent, as he can detect any undue expenditure on the part of any or all of the shops and prevent repetition. This is the only way in which to minimise our shop-expense charges.

SHOP EXPENSE ORDER.

DATE ISSUED, *26/11/09.* To Foreman of *Foundry.* NUMBER *381.*

Pease have made for the Machine Shop
Casting to sample, charging all labor
and material to undernoted charge.

Copies Sent To:—*Timekeeper, Foundry, Cleaning Shop, Machine Shop.*

Classification No. *37/17.*

Signed, *H. W. Jones,* Foreman of *Machine Shop.*

Approved, *J. G. Webster,* Superintendent.

Cost of Labor $......... Cost of Materials $......... Total Cost $.........

FACE OF FORM FOR ORDERING REPAIRS.

It may be argued, however, that it is not necessary for a foreman to get an order signed by his superintendent for every little thing he requires to be done in or by another shop. This question must be determined to some extent by the conditions prevailing in the works, but I would suggest that for shop-expense orders for minor amounts, say under $10, the signature of the foreman should be a sufficient warranty for the carrying out of the orders, but for items which are likely to cost a much larger sum these orders should be considered duly authorized only when the signature of the superintendent is appended thereto. For instance, supposing the foreman of the foundry reports that he requires repairs to a machine which in his opinion will cost about $150 to put right. It might of course be proper for him to go ahead with the work, but in the first place it should be necessary for him to call the attention of the superintendent to the repairs which he considers necessary, and if everything is O. K., the superintendent will not hesitate to append his signature to the order. On the other hand, however, it might be found that it would be far more practical to get a new machine altogether, or to do the repairs in some different way from that originally outlined by the foundry foreman. I would like to lay particular stress upon the necessity of frequent consultation between the foreman and superintendent, especially in connection with matters of shop expense, as it is here in many cases that we find the causes for our high burdens. By using such means as these a superintendent is enabled to keep a much closer tab on all that is going on in the different shops; and in a large plant countless repairs and replacements are necessary, and I should imagine that unless some similar system to the one here outlined is in force, it would be almost impossible to look after the hundred and one jobs that crop up every day. It may also be noted that on the shop-expense order form, each foreman or his clerk has to enter up the men's time and the materials used on each of these jobs, so that when the work is completed, the management knows at once just how the expenses are running; but more than that, they know which shop is costing the most in proportion for upkeep and can at once lay their hands on any leakage that may exist.

In looking over an article on cost accounting that appeared in the *Iron Age* some time back, I was very much struck with the opinion of the writer who said that too much "paper work" was as bad as none at all, as where so much detail is gone into the management has to keep an excessive number of clerks in order to get out the details required by them. This is unquestionably true, and one must guard against such a condition of affairs. The simpler the cost system the better, so long as it gives the superintendent and management the pertinent facts, upon which so much depends. My idea in these papers has been to avoid as far as possible an overburdening amount of paper work, but yet at the same time to retain all the valuable information.

In connection with the issuing of shop-expense orders, it is always expedient that the form used should be as explicit as possible, otherwise a good deal of time is wasted in making explanations, or making quite clear to the different foremen what is actually required. In order to prevent this a few rules might be drawn up relative to these, and a copy given to every one having anything to do with shop expenses. I would therefore suggest the following as being practical, and worthy of consideration:—

1.—When it is necessary for one shop to make requisition on another for any work whatsoever, it is requested that the foreman state explicitly on the shop-expense order what is required.

2.—He should also give enough information so that the timekeeper and cost clerks looking after the work can correctly distribute the several expenses.

3.—For orders where the cost is not likely to exceed the sum of ten dollars, the foreman of the shop upon which the order is drawn should honor same if signed by the foreman of the shop issuing it. In the event of an expense costing more than this sum it is essential that the order be countersigned by the superintendent.

4.—Any order issued for repairs to machinery should specify the number of the machine on which such repairs are to be made.

Other rules may of course be added at the discretion of the parties handling these orders, but in the majority of plants I venture to think these will be sufficient.

It must be borne in mind, however, that it is imperative these rules be faithfully carried out, and that obedience be insisted upon, or else we shall soon find out that the information we are getting is not of much value.

Here, then, we have a very simple method of dealing with the various expenses that are bound to occur in our works, and I believe that if the orders are carried out on the lines suggested in this paper we shall be able without much effort on our part to detect the causes of high burdens in the shops, and to reduce them accordingly. As before stated (and I think it worthy of repetition) strict adherence to the rules laid down is essential, and must be enforced at any cost.

There is no excess of paper work in this order system, as the requisite number of copies of each order can be made at one writing on the typewriter, and distributed to the various shops by the timekeeper.

In conclusion I would urge the necessity of co-operation on all sides, as it is only by unity of purpose that the desired ends can be reached.

In the concluding article of this series it will be my endeavour to bring together all the information necessary for compiling our final cost reports, and to show how the information so collected may be put to the best use.

THE REVIVAL OF THE RECIPROCATING ENGINE.

By R. J. S. Pigott.

I. COMPARISON OF THE ENGINE AND TURBINE THERMAL CHARACTERISTICS.

Mr. Pigott's theme is the very high economy in the production of power secured by the large piston engine combined with the low-pressure turbine. His article in this issue deals with thermal considerations and problems of design in getting up a good combination unit. A second paper, in August, will discuss practical applications, either to new installations or revision of old reciprocating-engine plants by the addition of low-pressure turbines.—The Editors.

SINCE the development of the low-pressure turbine in Europe, and its recent advent in large units in America, the builders and owners of reciprocating engines are taking fresh interest in the possibilities of economical power production by piston machines. The low-pressure turbine, until recently, has been used chiefly in connection with a regenerator, to render a comparatively uniform and economical power supply from the irregular exhaust of one or several uneconomical engines operated intermittently. It is now applied directly to a single engine operating continuously, and without a regenerator, to carry expansion of the steam to a point far beyond the economical reach of the reciprocating machine. This combination has such marked advantages in economy over both reciprocating engine and high-pressure turbine, that it becomes a formidable rival to the two simple types in many fields.

The theoretical considerations which make these advantages possible are quite simple. Assuming a given initial condition of steam, p_1v_1, the work per unit weight obtainable by expansion, if there are no losses by friction, leakage, radiation or conduction, is shown by the area A B C D, Fig. 1, represented by the familiar $\int vdp$ where $pv^{1.126} = c$ is approximately true for adiabatic expansion. This area could be realized only in an engine with no clearance, instantaneous valve opening and closure, no leakage, non-conducting cylinder walls, and unlimited port area; or in a turbine with no nozzle and wheel friction, non-conducting shell, no exit velocity from the wheels, and no internal steam friction. These conditions are, of course, never realized. But the nature of the losses in the two machines is entirely different, and changes enormously with the pressure range; this is where the combination engine-turbine unit gets its chief advantage.

Generally the most important loss of the reciprocating engine is condensation, caused by conductivity, heat capacity of the cylinder walls, and bad drainage of the cylinder. Few realize the enormous influence of a small amount of water in the cylinder upon the heat transfer and state of the steam contained therein. Initial condensation forms the greater part of the total condensation. At the time of admission the cylinder walls and all other metal bounding the clearance space are all at a temperature somewhere between the average temperature and the lowest temperature of the engine cycle, and are comparatively cool. The compression of a small amount of steam in the clearance space does not serve to increase their temperature very materially; consequently the incoming steam is chilled by the cool surfaces and throws down some water. This condensation is rapidly increased, not only by the additional cool surface exposed as the piston moves away, but by the deposit of the condensed water film on the surfaces, which enormously decreases the resistance to heat transmission, and so assists the increase of moisture. This action probably continue until the rising cylinder-wall temperature equals that of the steam. Then the action reverses and the hot metal gives up most of the heat absorbed to the water film, some of which is then re-evaporated. We can safely say "most of the heat" because in a modern engine, with good lagging, the actual radiation and conduction to the surrounding air need be very little—not more than 2 per cent. Consequently 98 per cent is returning to the steam during the remainder of the expansion stroke and the exhaust stroke when the steam temperature is lower than the cylinder temperature. The heat transferred during exhaust is useless to do work in the cylinder and only goes to increase the intrinsic energy of the exhaust steam, so that not as much energy has been given up by the steam as if no condensation took place. This is all right in the case of a high-pressure cylinder where the exhaust steam is to be re-used in a second cylinder; but in the case of the last cylinder, the extra heat returned to the steam goes to the condenser and is lost.

The actual temperature range in the cylinder walls is much smaller than is ordinarily supposed. At a depth of .01 inch below the surface it is about 1/10 or 1/11 the steam-temperature range, and at the surface, not much greater than 1/7 to 1/9; so that the loss from condensation in well lagged cylinders is generally much less than is ordinarily believed. The popular idea is that condensation losses are chiefly due to radiation and conduction, but they are really due to the alteration of the heat contents of the steam at different periods of the stroke by the presence of a small quantity of moisture, so that the steam leaves the cylinder dryer than if a true adiabatic expansion had taken place. This implies that less heat has been withdrawn from the steam and consequently less work has been done per pound. In addition to these, the jet action of the steam etering the cylinder may become considerable and the work of projecting the mass of steam at fairly high velocity and reduced pressure with imperfect compression, produces moisture; the kinetic energy generated is used up on the cylinder walls as heat of impact. While little or no attention has been paid to this point, it may be that, insignificant as this thermo-dynamic action seems, it is just enough to start much more serious condensation action.

The item of leakage is nearly as important as condensation, and in many cases without doubt, is actually greater. For, although most designers think that their own pet packing design is a puzzler for the steam, the actual commercial products have a suspiciously similar look—all have one or two comparatively narrow sliding surfaces, which are supposed to be in close contact—so they may be when new—and cold! But the amount of water and steam that can leak by a capillary opening, such as obtains with pistons and all forms of sliding or rotating valve, is incredibly large—out of all proportion to the amount leaked when the orifices are measurably large.

Indeed, one of the chief reasons why no generally applicable formulæ for missing water have been offered, is the uncertainty of this leakage factor. No one can predict by formulæ just what the leakage may be past piston and valves. The remaining departures of the actual engine from the ideal are due to purely mechanical limitations; clearance, rounding of corners of diagram, non-completion of expansion, and in compound and triple-expansion engines, pressure drop at release in high-pressure or intermediate cylinders.

The absolute amount of all these losses is usually approximated by formulæ involving constants which are determined by actual tests upon any engine under consideration, or if these are not available, by tests from similar types of engine.

Initial condensation will be proportional to: (a) temperature range; (b) surface exposed; (c) time of exposure; consequently initial condensation will vary in some function of ratio of expansion, cylinder diameter and speed. Ratio of expansion, r, is defined as total volume divided by cut-off volume. Condensation by expansion will also be proportional to r. Leakage past valves and piston will increase with pressure range and consequently with heat interchange, and therefore condensation and re-evaporation will be less as period is reduced or speed increased. The other mechanical losses are questions of design and are practically the same in all well-designed engines.

From the above, we should expect the missing water to vary according to some function $f(r, d, p_1, n) = y$

where $r =$ ratio of expansion
$d =$ cylinder diameter.
$n =$ number of revolutions
$p_1 =$ initial pressure

Various formulæ have been used:

$$y = c\,\frac{1+r}{d\sqrt{n}}, \quad y = \frac{c^1(1+r)}{d\sqrt{np_1}}, \qquad \text{—Perry.}$$

$$y = \frac{c^{11}\log r}{d\sqrt{n}} \qquad \text{—Cotterill.}$$

$$y = \frac{c^{111}\sqrt{r}}{d\sqrt{n}} \qquad \text{—Thurston.}$$

$$y = r\left\{\frac{a}{np_1} + \frac{b}{d\sqrt{n}}\right. \quad \text{a \& b are constants.} \qquad \text{—Callendar \& Nicholson.}$$

The interpretation of all the above formulae is: missing water is less as cut-off is longer; is less as the engine is larger; is less as the speed is greater; and in a small degree is less as the initial pressure is greater. The variation of form shows how uncertain the whole matter is. But we should expect that a non-condensing engine would come nearer to the ideal than a condensing engine, since ratio of expansion is the most important factor. This is borne out by fact; take the engines at 59th Street, before and after installing the low-pressure turbines. Pressure, speed, and dimensions are the same; consequently missing water becomes a function of r only; running condensing with r approximately 20 or 22 at nominal load, the efficiency referred to the Rankine steam cycle never rose above 60 per cent; whereas when operating non-condensing, r approximately 8 or 10, efficiency nearly reached 80 per cent. In fine, the reciprocating engine is a much better machine for transforming heat to work above atmospheric pressure than below, although the actual water rate, when running non-condensing, is much higher, because the ideal cyclic efficiency is less. This applies both to simple and compound engines, if the initial pressure is over 125 pounds. As an example, the 59th

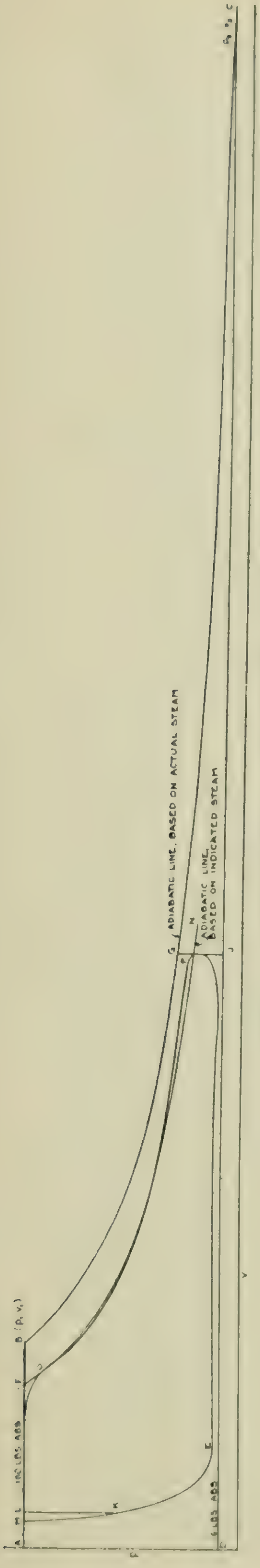
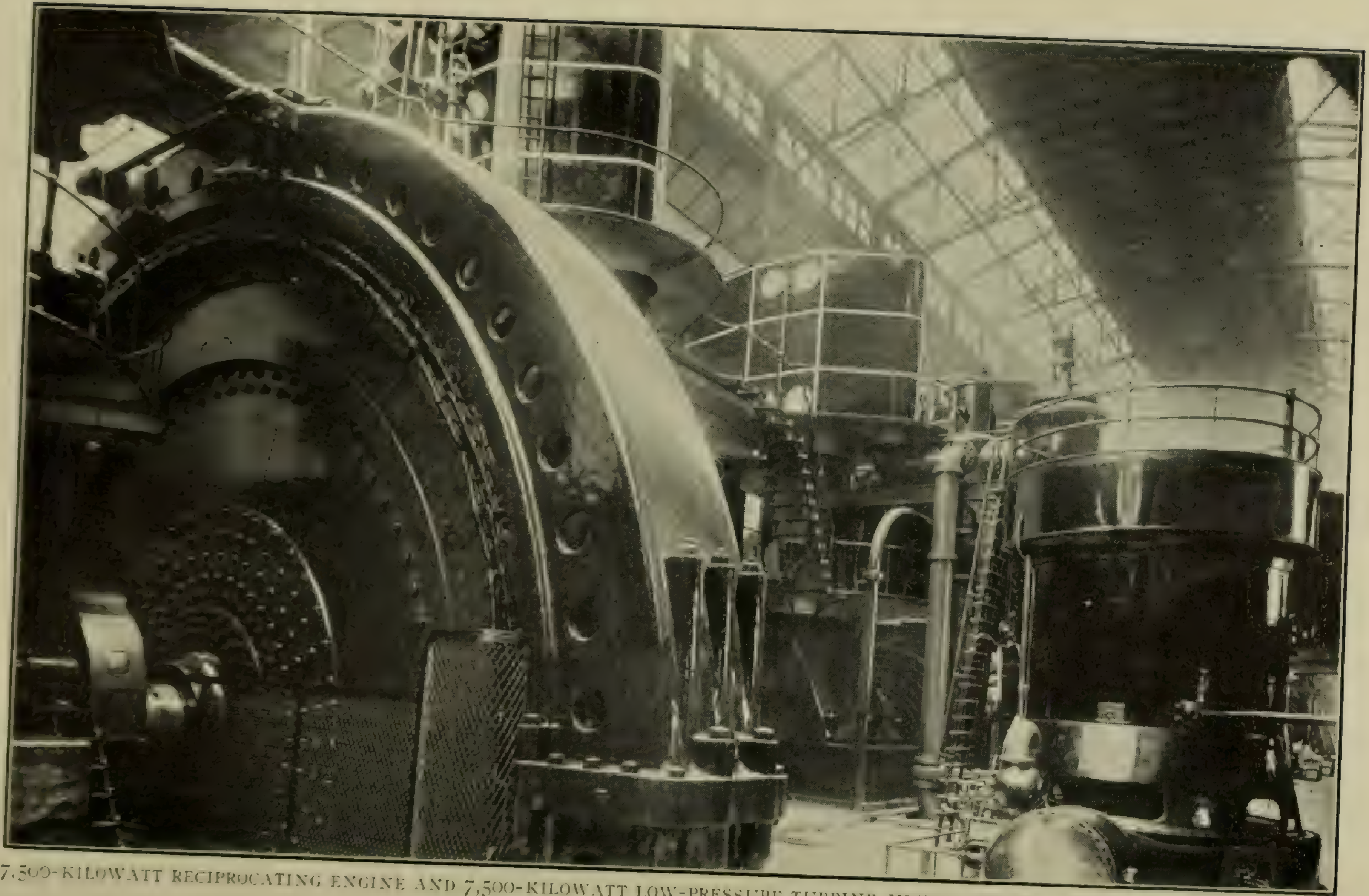

ADIABATIC LINE, BASED ON ACTUAL STEAM
ADIABATIC LINE, BASED ON INDICATED STEAM
G
P
N
J
B (p, v)
O
F
160 LBS. ABS
E
K
L
M
A
6 LBS. ABS
C
V

FIG. I. SIMPLE NON-CONDENSING ENGINE.

Street engines running condensing, gave a kilowatt hour on 17.1 pounds dry steam at 4,600-kilowatts load, when the ideal engine would have given a kilowatt hour on 9.1 pounds, which gives 59 per cent efficiency referred to the ideal; the thermal efficiency of the ideal engine for these conditions is 28 per cent, giving a thermal efficiency for the actual engine of 16.7 per cent. Running non-condensing, exhaust going to the low-pressure turbine, the engine gave a kilowatt hour on 24.6 pounds dry steam, the ideal engine using 19.3 pounds, or 78.5 per cent efficiency for the engine; the ideal thermal efficiency is in this case 17.6 per cent, giving 13.8 per cent thermal efficiency for the actual engine. These are all over-all efficiencies, and include the generator losses—the generator efficiency alone being from 97.5 per cent to 98 per cent. The triple-expansion engine does not enter into the field to any great extent, as there are practically no examples, except marine engines, to which a low-pressure turbine might reasonably be applied.

The losses in a simple engine can be easily understood from Figure 1, where A, B, C, D, is the work area by a true adiabatic expansion from dry steam at p, v, and is the card upon which the Rankine ideal cycle is based. A, F, shows the reduced volume due to initial condensation, the expansion line from o to p following no simple law exactly, although it follows approximately some such law as $pv^{1.106} = c$ or sometimes $pv = c$, this last being frequently miscalled the "theoretical" expansion line.

G, C, J is the loss due to incomplete expansion. The area K, L, M, is part of the loss due to incomplete compression in the clearance space, the remainder of the loss being in the departure of E, K, M from an adiabatic compression. The actual steam per stroke is represented by the difference A, B and A, M.



7,500-KILOWATT RECIPROCATING ENGINE AND 7,500-KILOWATT LOW-PRESSURE TURBINE INSTALLATION. 59TH STREET PLANT OF THE INTERBOROUGH RAPID TRANSIT COMPANY.

Allis-Chalmers Engines. Curtis Steam Turbine.

Figure 2 shows the same characteristic losses for the compound engine, but the amounts are reduced, since for the same ratio of expansion, the temperature ranges are halved, clearance reduced, and an opportunity given to drain away some of the injurious moisture. But on the other hand, while missing water is thus much reduced, valve losses, as evidenced by rounding of the card, are increased, and an additional radiation surface in the shape of a receiver is introduced, also a slight additional loss from the usual drop from high-pressure release to receiver pressure. There is, however, a very substantial gain, in spite of these losses, in favor of the compound.

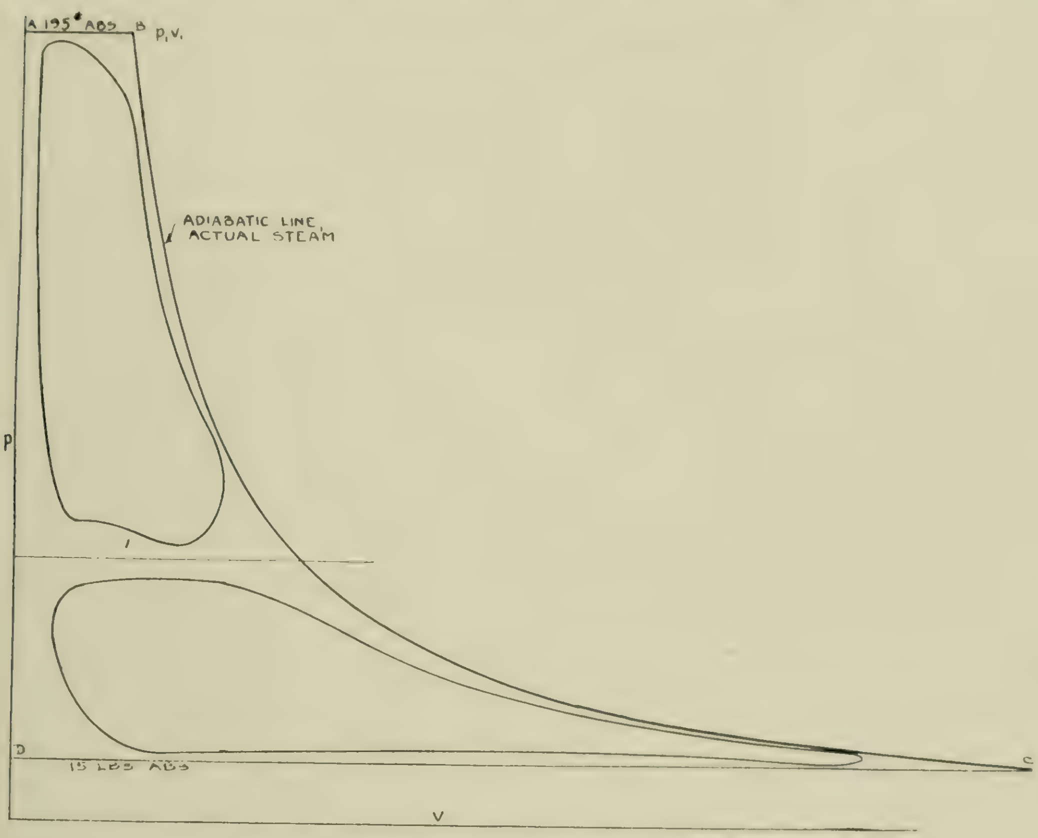


FIG. 2. COMPOUND ENGINE, NON-CONDENSING.

In the turbine, the principal losses are: internal nozzle friction, skin friction, wheel friction, exit velocity, and in the case of reaction machines of the Parsons type, leakage around blade ends. Radiation from the turbine to the surrounding air is almost immeasureable, as the surface presented to the air is very much smaller, compared to the power, than in the case of the engine. It is easier to insulate the turbine thoroughly, not only because of the simplicity of the lagging and the absence of externally moving hot parts, but because of the absence of large bodies of metal (such as the guides, piston rod, valve bonets and gear in the engine), leading from the steam chambers to unlagged cool parts. In the steam engine the guides, rod, and valve fittings probably account for more dissipation of heat than the whole radiating surface of the cylinder.

The internal nozzle friction is due to variations of steam flow from the conditions for which the nozzles or wheels were designed, setting up eddies in the steam which use up a portion of the kinetic energy in useless, cross-currents, whose energy in turn is returned to the steam as friction heat. The blanketing of the steam by the sensibly thick blade edges and the windage of the wheels, have this same effect. That is, all eddy currents and friction go back into the steam as internal energy. The result is that the steam exhausted from one wheel to the next and finally to the condenser or atmosphere, is always much dryer and much higher in internal energy than if the expansion were adiabatic; consequently less work has been done.

The friction of steam, whether internal or skin effect, is much greater at high than at low pressure, on account of the much higher density and viscosity, so that a high-pressure stage is much less efficient as an energy transformer than a low-pressure stage. The efficiency as a transformer of a high-pressure nozzle and wheel usually amounts to about 62 per cent; that of a low-pressure nozzle and wheel about 71 or 72 per cent. In the case of the impulse type, the expansion nozzle is stationary, and the wheel merely a reversing guide; in the reaction type, the wheel and stationary blades all partake of both functions, but the losses are much the same in both cases. The increased efficiency of the nozzles and wheels becomes more and more pronounced as the pressure drops, so that the last vacuum stages probably have an efficiency of over 80 per cent. This is one of the reasons for the enormous gains in economy of the turbine with increased vacuum. Consequently the turbine is inherently a better machine for low-pressure work than for high.

The diagram Figure 3 will perhaps show a little more clearly the condition obtaining in the turbine. The work done by a true adiabatic expansion following a law $pv^{1.126} = c$ approximately from p_1v_1 to $p_2v^1_2$ is $\int_{v_1}^{v^1_2} vdp$, area A, B, C, D, and can be directly represented by $\lambda_1 - \lambda^1_2$, where λ is the total internal heat in any state. What actually occurs is shown by A, B, E, D, expansion following a law $pv^x = c$ and terminating in a different volume, v_2, and a higher heat contents, λ_2. The work done is still represented by $\lambda_1 - \lambda_2$ but not by $\int_{v_1}^{v_2} vdp$. The loss of effectiveness is represented by the difference of heat contents, $\lambda_2 - \lambda^1_2$.

The application of superheat to both turbines and engines effects an improvement in economy. The improvement in the steam engine is chiefly due to the elimination of most of the missing water, by providing enough superheat to counterbalance the chilling effect of the cool cylinder, without producing moisture. We should, therefore, expect a very large improvement with small superheat, say up to 75 degrees F. at the throttle, and very little additional improvement with higher superheats, as there is nothing to be gained by sending superheated steam to the condenser.

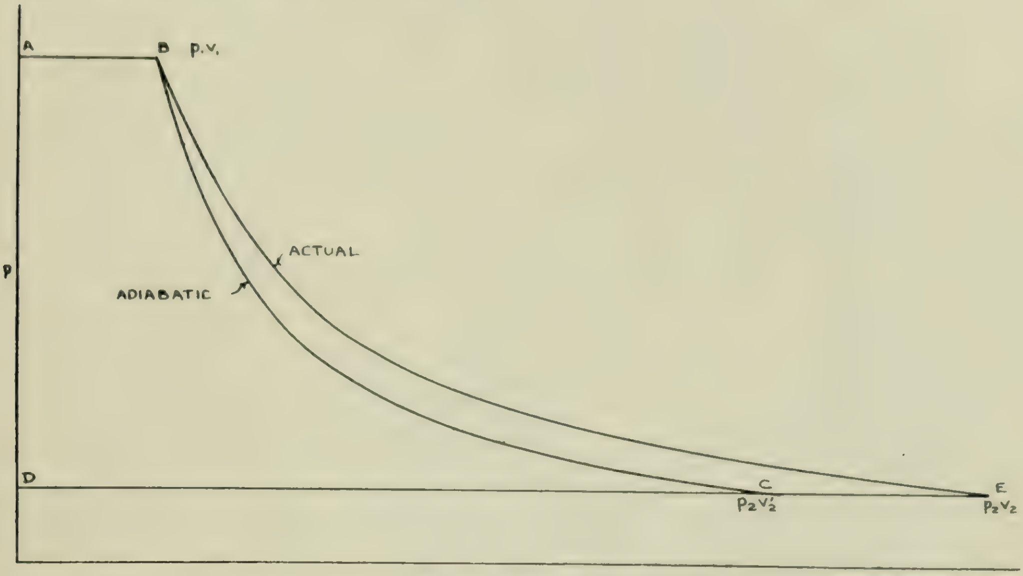
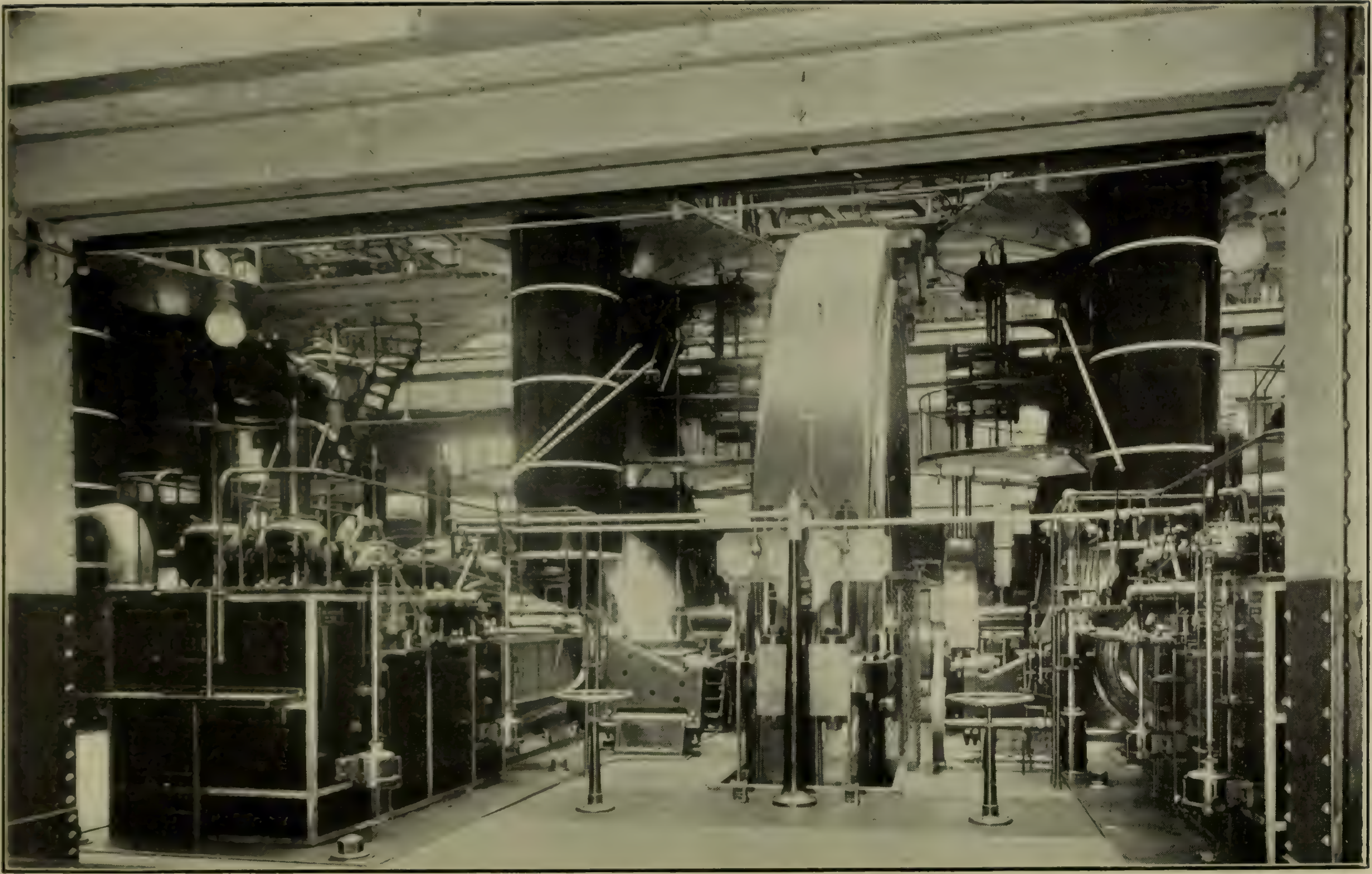


FIG. 3. TURBINE.

In the case of the turbine, the superheat effects its saving by cutting down the friction losses, so that the expansion is more nearly adiabatic. The viscosity and specific density of superheated steam are considerably less than those of saturated steam for the same pressures, and the elimination of moisture in the expansion reduces the friction enormously. We should expect very little additional saving when superheating beyond the point of saturation at exhaust; this is actually the case, the same as with the engine.

But these improvements in economy do not materially affect the basic fact that the engine is more efficient at high pressure, and the turbine at low pressure. The natural conclusion is that a combination unit giving each its most efficient place on the pressure scale, would prove more efficient than either alone. For, if the engine efficiency is 82 per cent non-condensing, and the turbine efficiency on dry steam is 70 per cent, running from atmospheric pressure to vacuum, a combination unit could be expected to reach an efficiency of about 74 per cent with properly divided load. This figure has already been realized. Figure 4 will serve to show the general character of the saving.



7,500-KILOWATT ENGINE, 59TH STREET POWER HOUSE OF THE INTERBOROUGH RAPID TRANSIT COMPANY, SHOWING VALVE GEAR. The modern high-pressure turbine under the same conditions is 13 per cent. more efficient. The low-pressure turbine combination is 25 per cent. more efficient. Allis-Chalmers engines; Westinghouse generator.

There are a number of very valuable advantages, which are incidental to the question of economy of steam. The principal advantage is the increase of power, which can be obtained in any overloaded engine plant, without appreciable increase in steam. There are many manufacturing plants of 500 to 2,000 horse power, whose owners are at their wits' ends to provide power enough, economically, without a very heavy outlay of money. In many cases where the factory has outgrown the plant, and where space and building room are available, the low-pressure turbine offers a splendid solution. Its small size will usually allow of its introduction without alterations to the building, or foundations already installed. If the engine steam piping is reasonably well designed, it will suffer no changes

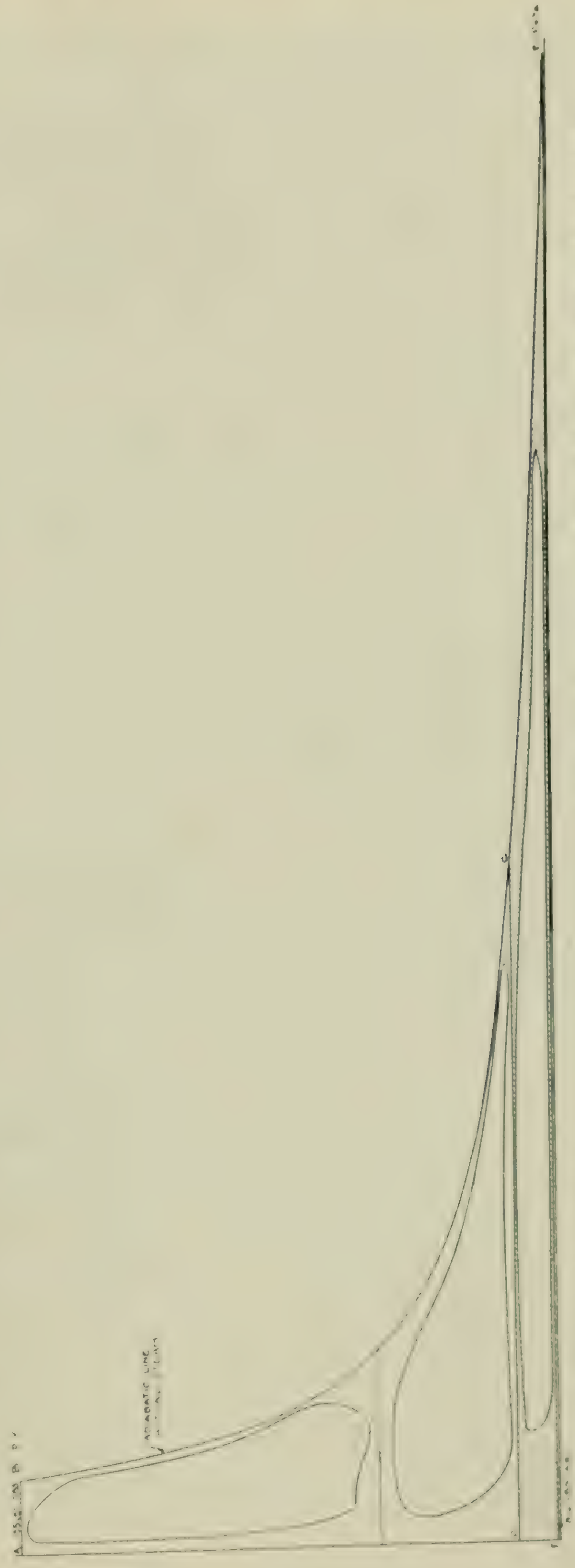
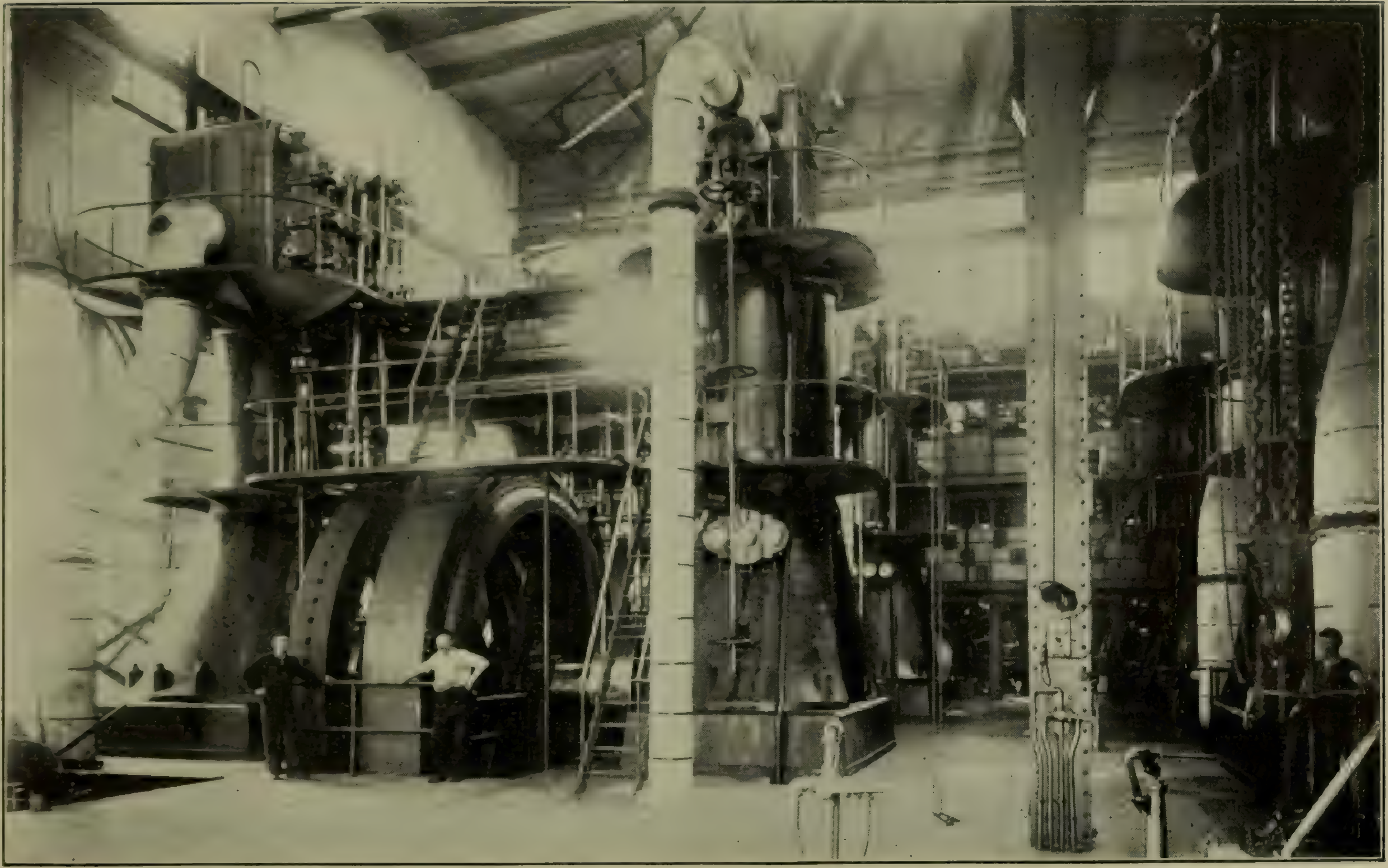


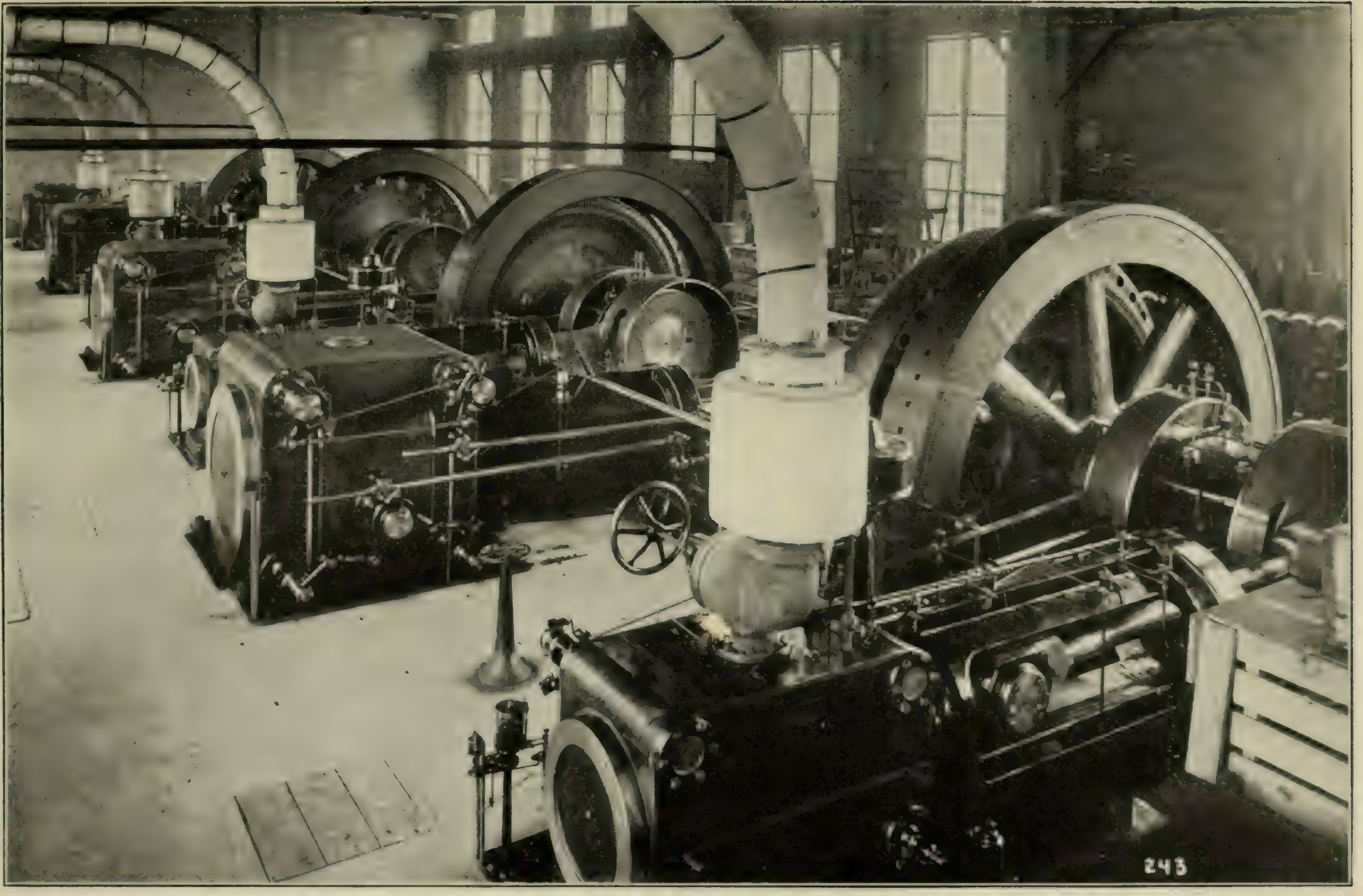
FIG. 4. COMPARISON OF A TRIPLE-EXPANSION ENGINE WITH A COMPOUND ENGINE AND LOW-PRESSURE TURBINE.

A B E F is the total available; D C E F, shaded portion, shows additional work from low-pressure turbine as against third cylinder.



TWO OF FIVE 2,400 HORSE POWER VERTICAL CROSS-COMPOUND CORLISS ENGINES, COAL STREET STATION OF THE PUBLIC SERVICE CORPORATION, NEWARK, N. J.

Wisconsin Engine Co. An installation of low-pressure turbines in this station is under contemplation.



FOUR 2,000 HORSE-POWER HORIZONTAL CROSS-COMPOUND ENGINES, ALIQUIPPA WORKS OF THE JONES & LAUGHLIN COMPANY. 28 and 56 by 48 in. At present working on saturated steam at 135 pounds. The Wisconsin Engine Co.

whatever. The auxiliaries, although larger, with the latest designs, take so little extra space that, in practically every case, they can be substituted for the original auxiliaries without further change. The addition of the low-pressure unit usually does not mean any addition to the engine-room force, as the turbine itself requires no attention that could not be given by an oiler already taking care of the engine, while the auxiliaries require only the same care as for the engine installation alone.

In may cases, where the load factor is high, the initial installation of the combined unit may prove advisable, since economy of operation then becomes of prime importance. In cases where the load factor is small, the high first cost of a combined unit militates against its adoption. It is in the case of the old plant which is overtaxed that the turbine has its strongest field.

In the next article the calculation of a typical case or two will be taken up.

THE COST OF LIVING; HAS IT RISEN, AND WHY?

By Alex. Del Mar.

Mr. Del Mar was formerly Director of the U. S. Bureau of Statistics. He is a recognized authority on the use of the precious metals as money and on other phenomena of finance.—The Editors.

ABLE speeches have been delivered in Congress and able articles have appeared in leading newspapers concerning the recent rise in the cost of living in the United States; yet none of them appears to have determined the fact definitely, or to have adopted a method which, when the fact was determined, was capable of disclosing its underlying causes.

What is meant by the cost of living in the United States is not merely the wholesale unit prices of the ninety-six commodities embraced in Bradstreet's very excellent and reliable American Price Tables, or the wholesale quantitative prices of a similar list of commodities in Saurbeck's British Tables; but the actual cost of rent, services, commodities and miscellanies to the average American citizen. To add the cost of a pound of butter at 30 cents to that of a pound of flour at 3 cents, and compute the cost of bread-and-butter at 16½ cents per pound, would be no more erroneous than the method employed in some of the otherwise very admirable articles which have been published on this subject; while as to rent, which is the heaviest article of expenditure to the average citizen, it is not so much as mentioned in any of them. Neither is coal mentioned. A "ton" of this fuel used to weigh 2,240 pounds and cost about $5 or $5.50; that is to say, the consumer used to get something like 4 pounds for a cent. The poor man's "ton" now does not commonly weigh over 1,500 pounds and costs $6; he gets but 2½ pounds for a cent. As the usual consumption of the average Northern household varies from 10 to 30 tons a year, this item forms no inconsiderable element in the cost of living. It is far more important than the majority of the commodities usually included in the quoted price tables.

Servants' wages and the cost of their maintenance; the daily expense of transportation (car-fares, commutation-tickets, expressage, etc.), the cost of the business-man's or working-man's lunch, the fees which he is obliged to pay to physicians, dentists and other professional men, and those smaller, but in the aggregate, commonly more important expenses which include the barber, the porter, the waiter, etc., all these are left out of view in these discussions. Yet they have to be met, and therefore have something to do with the cost of living.

We next turn to clothing, hats, shoes, gloves and underwear. None of these articles appear in Bradstreet's or Saurbeck's tables, yet they form a very considerable item of expense to the average citizen and especially to the American, because for reasons connected with our fiscal system the most important of these articles have come to be made of such flimsy materials that they scarcely outlast a single season; whereas in other countries a good suit of clothes lasts for years without appreciable deterioration. Similar considerations affect the expense for furniture, carpets, hangings, and indeed almost every article of household use. In other countries they have to be made to last; in the United States they are made to sell. Second-hand foreign furniture commands with us a higher price than new domestic furniture of the same styles and (apparently) the same materials. The flimsiness of American furniture, carpets, and other household goods causes them to wear away after very brief use, so that their renewal becomes a far more important item in the cost of living than it is in other countries; yet these articles nowhere appear in the tables of prices which have been published concerning the cost of living. It is true that furniture would be a difficult commodity to describe, classify and quote; but such is not the case with carpets, rugs, oilcloths, hangings, blankets, bedding, etc., all of which are classifiable and amenable to definite quotation.

DEFECTIVE METHODS.

The result of employing defective methods is that in some of the researches which have been made, no definite conclusion has been reached; while in others the conclusion has been erroneous, it having actually been shown by at least one writer that the cost of living has not risen, whereas universal experience and more rigid research combine to attest that it has risen, and risen very materially.

Fortunately for the determination of the matter we possess criteria that will not be questioned. These are the carefully compiled and officially promulgated data prepared by the Bureaus of Statistics and Labor in the Department of Commerce, from which the following Tables are quoted. For purposes of comparison we begin with the wholesale prices.

WHOLESALE PRICES—ALL ARTICLES

"The average wholesale prices of 258 staple commodities during the ten years," 1890-1899 being reduced to 100, the relative prices of the same articles in each year separately, commencing with 1897 were as follows: 89.7; 93.4; 101.7; 110.5; 108.5; 112.9; 113.6; 113.0; 115.9; 122.5; 129.5; 122.8; 126.5. So that if to purchase these commodities during the last decade would have cost $100, in 1900 they would have cost $110.50 and in 1909 $126.5; showing a rise since 1897 of 41 per cent.

WHOLESALE PRICES—FOOD ONLY.

Included in the 258 staples above quoted are 57 of "Food, etc.," and these being based at 100 during the decade 1890-1899, they exhibited the following relative prices in each year separately, beginning with 1897: 87.7; 94.4; 98.3; 104.2; 105.9; 111.3; 107.1; 107.2; 108.7; 112.6; 117.8; 120.6; 124.7. This table shows that the advance in the wholesale prices of food, etc., has kept almost equal pace with the advance in wholesale commodities generally. We now turn to retail prices.

FOOD—RETAIL PRICES.

The following table shows the relative quantitative prices in each year since 1897 of 30 selected articles of food, the relation being based on 100 for the average quantitative prices during the decade 1890-9:

Year.	Simple prices.	Quantitative prices.
1897	96.3	96.3
1898	98.5	98.7
1899	99.6	99.5
1900	101.5	101.1
1901	105.5	105.2
1902	110.9	110.9
1903	110.9	110.3
1904	111.6	111.7
1905	112.5	112.4
1906	116.2	115.7
1907	120.7	120.6
1908	125.0	124.8
1909	129.1	130.4

The computations for the last two years are unofficial.

The articles included in the above table are dried applies, dried beans, roast beef, beefsteak, salt beef, wheat bread, butter, cheese, chickens, coffee, corn meal, eggs, fresh fish, salt fish, flour, lard, milk, molasses, pork, salt bacon, salt pork, potatoes, prunes, rice, sugar, tea, veal, and vinegar. The quantitative price is computed by giving to the relative price of each article its proper weight, as determined by the average consumption in 2,567 families of workingmen. It will be observed that in the case of food, there is very little difference between the simple and quantitative prices; but this is not the case with other commodities.

FOOD—RETAIL PRICES OF PRINCIPAL ARTICLES.

If we select from the 30 articles of food the 6 most important ones, their relative retail prices would run as follows:

Year.	Beef, steaks.	Wheat flour.	Butter	Pork fresh.	Potatoes Irish.	Eggs.
1890-9	100	100	100	100	100	100
1897	100.2	104.3	93.1	97.6	93.0	91.4
1898	102.0	107.4	95.1	98.6	105.4	96.2
1899	103.9	94.6	97.7	101.7	96.1	101.1
1900	106.4	94.3	101.4	107.7	93.5	99.9
1901	111.0	94.4	103.2	117.9	116.8	105.7
1902	118.5	94.9	111.5	128.3	117.0	119.1
1903	112.9	101.2	110.8	127.0	114.8	125.3
1904	113.4	119.9	109.0	124.0	121.3	130.9
1905	112.9	119.9	112.7	126.6	110.2	131.6
1906	116.5	108.1	118.2	137.7	114.4	134.2
1907	120.6	117.7	127.6	142.5	120.6	137.7
1908	124.6	118.5	131.2	144.9	123.1	144.1
1909	138.3	120.4	134.7	143.8	124.9	142.5

It will be noticed that the results are practically the same. Prices have risen about a third.

RENTS.

With regard to rents we have no comprehensive official data, while the alteration in building laws and other circumstances render comparisons difficult; but it is a well-known fact that during the past decade rents have slowly though steadily advanced. In our principal cities a class of apartments that ten years ago rented for $30 a month, now command $40. In the case of the better class of apartments, those which rented for $8 to $10 per room per month, now fetch $10 to $12; while the rooms themselves have grown smaller and the buildings higher. It is the opinion of an experienced manager of such estates that apartment rents in our principal cities have advanced during the last ten years from 15 to 25 per cent.

CLOTHING AND HOUSEHOLD GOODS.

Comparing not the prices of, but the actual outlay for, clothing, hats, shoes, gloves, underwear, furniture, carpets, hangings, bedding and household goods at the present time, we find that there has been since 1897 a rise of 40 to 50 per cent, the articles of most common use varying from 35 to 45 per cent and those of less common use from 40 to 50 per cent advance over what they formerly cost to purchase or replace.

THE WORKINGMAN'S FOOD.

The official price table which exhibits the least advance is that of the cost of food consumed by 2,567 workingmen's families, each year from 1890 to 1907. This table does not include the cost of rent, clothing, hats, shoes, bedding, furniture, etc. The advance in the cost of food alone is shown to have been from $299.24 per family per annum in 1897, to $374.75 in 1907, a rise of about 25 per cent. This may reasonably be regarded as a rise from 1897 to the present time of 28 to 30 per cent. As the American workingman usually lives very closely to the limit of his means, a rise of but 25 to 30 per cent in food expenditure, against a general rise of 35 to 40 per cent, rather indicates that the average rise in wages (union and non-union wage-earners combined) has not quite kept pace with the general rise in the cost of living.

Export Prices.

The statistics of domestic exports, which amount in the course of a decade to something like 15 billions of dollars and which are based on sworn manifests of each item separately, exhibit more striking results. Not to fatigue the reader with too many figures, we select a dozen leading articles from the export summaries and show their average prices during the entire years 1898 and 1908, the last mentioned being the most recent year shown in the official compendium of total comparative exports and their average prices. In this table the average rise of prices is close to 50 per cent. If it included exports of 1909 and 1910 it would exhibit a rise of over 50 per cent.

Export Prices of Twelve Leading Domestic Articles of Export from the United States During the Fiscal Years 1898 and 1908 Respectively.

Articles.	1898.	1908.
Boards, deals and planks, M. feet	$15.28	$23.00
Cotton, raw, pound	.059	.118
Cotton, manufactured, yard colored	.052	.072
Cotton, manufactured, yard uncolored	.048	.067
Bacon and hams, pound	.077	.109
Lard, pound	.056	.091
Pork, salted, pound	.056	.089
Beef, pound	.055	.068
Butter, pound	.15	.218
Cheese, pound	.086	.129
Leather, sole, pound	.175	.211
Boots and Shoes, pair	1.39	1.75
Together	$17.484	$25.922

This important table exhibits an advance of 50 per cent in prices.

The Fact.

Casting the view back to the period about the beginning of the present century, we find that wholesale prices have advanced about a third; retail prices of food, over a third; the average man's outlay for rents and services about a third; for clothing and household goods, over a third; the cost of the workingman's food (alone) about 30 per cent, and the prices of export goods (staples) alone, about one-half or 50 per cent; the general result being that, taking quantity, quality and numbers into consideration, the average cost of living in the United States has risen about a third, with a decided tendency to still further advance.

Commodities and Dollars.

Reverting from the prices to the denominations in which they are couched, these are dollars and cents, the latter being portions of dollars. The method is quite correct; indeed there are no other terms in which they could be quoted, because all commodities are bought and sold for dollars. But in such quotations the important consideration is usually lost sight of: that while the commodities might be the same, one year with another, the dollars are *never the same.* The comparison is therefore scientifically inexact; in other words, the trend of prices shown in the price tables, is always erroneous in degree and may even be so in direction. Suppose we compare the purchasing power of a dollar in the time of Washington with its purchasing power to-day. Would any intelligent person claim that they were the same? In 1790, after the Continental issues were repudiated, and before the Bank of the United States was established, the population was about 4,000,000 and the number of dollars in use about 20,000,000, or say $5 per capita. There were no railroads to move these dollars rapidly from place to place, no bank notes to suppplement them, practically no banks to lend them out and keep them in circulation, no telegraphs to multiply their usefulness, and no clearing-houses to issue "certificate" dollars at a pinch. The only dollars in use were metallic ones; and each man kept his bank in his pocket, or in some secret hoard.

At the present time, with a population of 90,000,000, there are 3,104,547,273 dollars in circulation, amounting to $34.45 per capita (Treasury Statement May 2, 1910); to say nothing of the $500,000,000 of "emergency currency," all printed and stored ready for use in the United States Treasury building, or the "200 or 300 millions" of Clearing-House certificates which may be issued in case of another panic. Would any intelligent person claim that the dollar of 1790 and the dollar of 1910 was the same measure of value, the same criterion of price? Of course not. Nor has it it been exactly the same in any one of the intervening years, during which dollars were increasing from $5 to nearly $35 per capita of population.

Velocity.

There is another consideration to be borne in mind with reference to the dollars employed in comparative tables of prices: the more rapidly such dollars pass from hand to hand, in other words, the more often the same dollars can be used for payments in a given interval of time, the greater the influence they must exert in raising prices. This is a function and peculiarity of money which is admitted and recognized by all the economists, a peculiarity which is well known to bankers and other dealers in money and which has been made the subject of numerous scientific researches, yet one which is rarely held in mind by the ordinary compiler of price-lists. Sixteen years ago (1894) as the result of an elaborate investigation into the phenomena of prices, the velocity of money in the United States was estimated at 52 times a year, or once a week, and in Great Britain at 180 times a year, or once in 2 days; a disparity that was found to be due chiefly to the relative geographical areas of the two countries. At the present time the velocity in the United States is probably not less than 60 times a year, or once in 6 days; in other words, that all the dollars in circulation in the country are used over and over again in payments 60 times during the year. How often the dollars of 1790 were used and re-used, we have no means of determining; but it will probably not be far wrong to estimate it at once a month. It would follow that the dollar of to-day was five times more rapid, useful and effective and therefore more influential in promoting trade and determining prices than the dollar of Washington's time. The bearing of this circumstance upon the common method of measuring the trend of prices from comparative tables, is obvious. It is that any comparison of prices, especially when made at distant dates, is scientifically erroneous, unless the quantity and velocity of money are both taken into consideration; for these, when multiplied into one another, form the practical measure in which such prices are couched. In the case of dollars which from any cause are imperfect, limited in legal functions, restricted in circulation, or liable to be hoarded or exported, certain allowances would have to be made; but for the sake of simplicity in endeavoring to discern the operation of a principle, we are assuming throughout full legal-tender gold dollars, in active circulation, within the country.

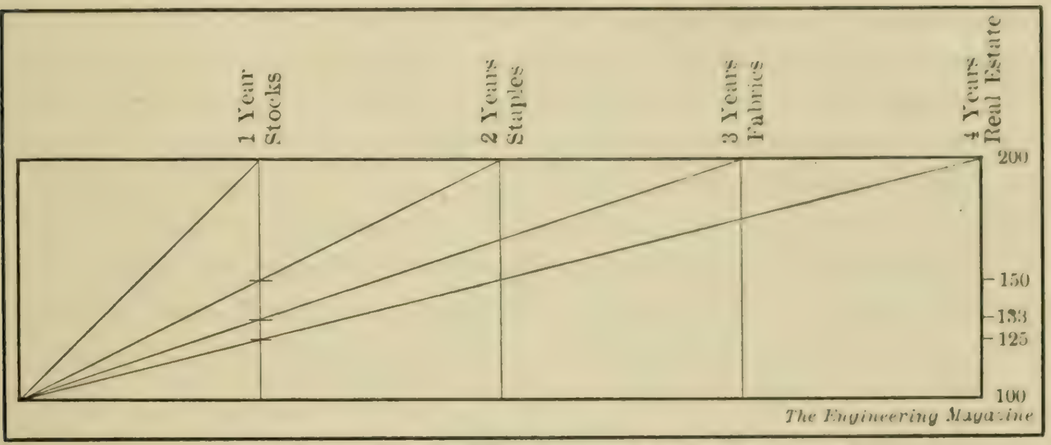
Assuming the total volume of the currency to be such as is above stated and the velocity at 60 times a year, the sum of exchanges ought to be $3,104,547,273 × 60 = $186,270,000,000. That such is the fact, or very close to the fact, is proved by the actual sum of clearings, which, for the year ended September 30, 1909, was reported by the 123 clearing-houses of the United States at $158,500,000,000. During the current year the clearings will probably amount to $175,000,000,000, and allowing $11,270,000,000 for exchanges that do not go through the clearing-houses, we have a grand total of $186,270,000,000 of exchanges, to offset the sum of currency multiplied by its ratio of velocity. These figures afford strong evidence that the theory of velocity is sound; and if so, it proves that, in considering the causes which have contributed to occasion a rise of prices, the increased and always increasing velocity of money, afforded by modern transportation, communication, and credit devices and agencies, should be taken into the problem. It would probably be hardly too much to say that, roughly speaking, fully one-tenth of the rise of prices during the past decade—whatever such rise may be—is attributable to the increased velocity of money, during the same period.

PRECESSION.

There is yet another consideration, one to which no place appears to have been given in any of the essays which have been published on the subject of the rise in prices. It is this; that when any impulse is given to prices by increasing the currency, or accelerating its velocity and thus stimulating trade, all prices do not rise at the same time and therefore not at the same ratio at any given time. For the sake of illustration, let it be supposed that the number of dollars in circulation or their velocity were suddenly doubled and kept doubled. Other circumstances being equal, it would seem that the general level of prices ought also to double and to double instantly; but such is not the course of nature. It has been observed that under such an impulse, some commodities will rise in price more promptly and rapidly than others. For example, stocks will rise almost instantly, while real estate may remain unaffected until a much later period. From the observations referred to, covering a long period of years, it appeared that in the United States, following an increase of money and taking no account of the time involved in geographically distributing the increase, it nevertheless required a period of several years for all prices to conform to such increase. During this interval the prices of a certain few classes of commodities or services doubled, after which the prices of others doubled, and so on successively, until the doubling of all classes was completed. In other words, the doubling of prices was not simultaneous, but took the form of a Precession, the order of which was somewhat as follows:—1. Railroad stocks; 2, other stocks; 3, shares of commercial incorporations; 4, crude and imperishable commodities; 5, perishable commodities, articles of subsistence, etc.; 6, fabrics, such as machinery, manufactured food, articles of wear, etc.; 7, real estate; 8, skilled labor; 9, unskilled labor; 10, professional services, or the emolument of authors, inventors, lawyers, engineers, clergymen, accountants, and other professional and clerical classes.

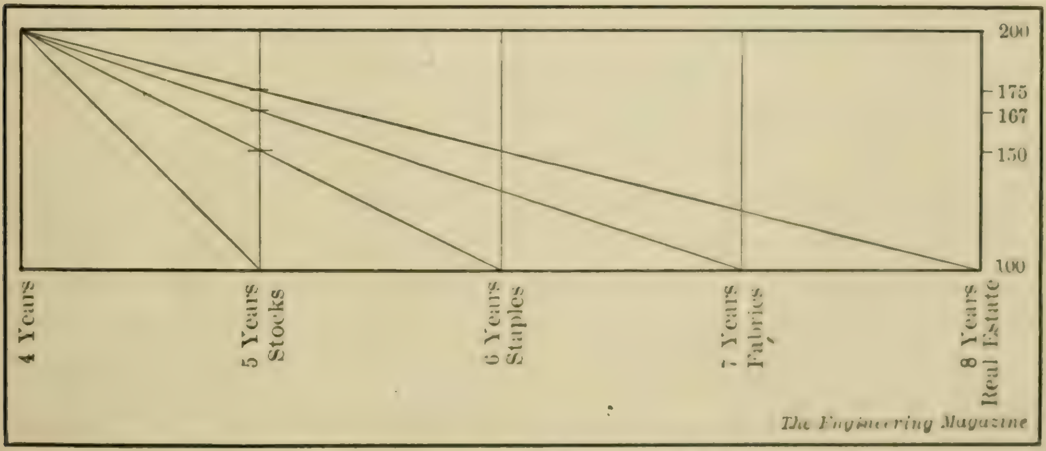
The interval between the doubling of the prices in these various classes of commodities or services was not uniform; in other words, supposing four years to be the time required for the entire doubling of prices, and the classes of commodities and services to be four in number, it did not follow that each successive year added one to the classes with doubled prices. After once commencing to feel the effect of the increased volume or velocity of money, some classes of commodities doubled in price more quickly than others.

For the sake of a simple illustration, suppose this actual inequality to be ignored and each year to add one to the classes of commodities with doubled prices; then the following diagram would theoretically illustrate the rise of each class at the end of each year.



A. HYPOTHETICAL RISE OF PRICES FROM 100 TO 200.

Thus at the end of the first year stocks are at 200, staples 150, fabrics 133 1/3, and real-estate 125. At the end of the third year, while stocks have enjoyed for two years a continuous market at 200, fabrics have recently and barely reached the same high level, while real-estate is still a year behind. This phenomenon is further illustrated by the following diagram, which assumes that at the end of the fourth year the volume or velocity of the currency is suddenly reduced to its former level.



B. HYPOTHETICAL FALL OF PRICES FROM 200 TO 100.

The effect of rapidly enhancing the volume or velocity of the circulation per capita is to place fabrics and real-estate at a disadvantage as compared with stocks and staples; because while the latter rise rapidly in price, the former rise slowly. Contrariwise, when the volume or velocity of money is not urged too rapidly beyond the growth of population and therefore of legitimate business demands and exchanges, then the farmers, manufacturers, laborers, and other producers of fabrics, are enabled to maintain prices, while stocks have fallen and become cheap, and while marketed and speculative staples have begun to decline.

Although in summarizing so comprehensive a subject as the comparative cost of living at different periods of time it may not be practicable to apply concretely the operation of Velocity and Precession to tables of prices, it will hardly be disputed that they have both had some influence on the cost of living; velocity, by tending to enhance all prices, and precession, by advancing the prices of staples (as shown in the export tables) far beyond those of any other classes of commodities except stocks, which have enormously and notoriously advanced in price during the period in question.

CAUSES OF THE ENHANCED COST OF LIVING.

Turning from the fact to the causes of the enhanced cost of living, the principal ones assigned by the various authorities who have examined the subject are as follows: 1, the tariff; 2, monopolies; 3, combination and "gentlemanly understandings" to enhance the prices of manufactures and farm products; 4, increased production of gold; 5, the demands of labor; 6, exhaustion of natural resources; 7, heightened standard of living; 8, extravagance of living; and 9, the congestion of population in cities.

With all respect to the authors of these researches, and after a careful examination of the causes alleged, some of which have undoubtedly contributed, and largely contributed, to occasion the rise of prices, we do not find that any of them, or all of them together, are sufficient to explain the whole extent of the rise.

WEALTH, EARNINGS, AND SAVINGS.

According to official figures, the National wealth advanced from $88,500,000,000 in 1900 to $107,000,000,000 in 1904, an increase in capital of about $4,600,000,000 per annum. The annual volume of production was: Farm products, (corrected to) $10,000,000,000; minerals, $3,000,000,000; lumber, fish and miscellaneous, $1,000,000,000; and manufactures (net), $10,000,000,000; total, $24,000,000,000.

Of our 90,000,000 of population, 35,000,000 are employed in gainful occupations, of whom about 29,000,000 are males and 6,000,000 females. These numbers include about 2,000,000 of males and 500,000 female children, 10 to 15 years of age. Their united earnings amount to about $34,000,000,000 a year, their expenditures to not much less, say $30,000,000,000.

What has to be furnished is a cause or causes sufficient to explain a rise of about a third in the cost, to the consumer, of the commodities and services represented or indicated by these colossal sums. This consideration disposes at once of nearly all the alleged causes. The tariff last year yielded little over $300,000,000; the increased production of gold has nothing to do with prices unless the gold is coined into money and employed in the circulation. The increased amount so coined and employed is too trivial in comparison with the national measure of the cost of living to be worthy of consideration in this connection; the demands of labor are primarily and mainly a consequence rather than a cause of the enhanced cost of living; the heightened standard of living, the extravagance of living, and the economical effects of urban congestion are all included in the gigantic figures which form the base of the problem; the exhaustion of natural resources is offset by the discovery and utilization of new resources; while neither is sufficiently tangible to practically contribute anything towards a solution of the question.

There remain only two of the alleged causes to consider, and these are essentially one cause; the influence of monopolies, combinations and "understandings" made in restraint of trade, or with the object to maintain or enhance prices. There can be no doubt that among the causes alleged, this is the principal one; nor can it be disputed that the tariff, by creating or upholding monopolies, has largely contributed toward the rise. But we can only find an adequate explanation of the rise in two other causes, both of which are commonly left out of view in these discussions. These are the Total Weight of Taxation, and the Expansion of the Currency.

THE WEIGHT OF TAXATION.

In 1909 the Federal Government disbursed over $1,000,000,000. In 1902 (the latest official statistics) the various States, counties, cities and towns disbursed $1,156,000,000, a rate of expenditure which by this time probably amounts to $1,500,000,000 a year, making the aggregate cost of government about $2,500,000,000. The Federal taxation to provide for these disbursements falls chiefly upon articles of consumption, and at least to that extent it enhances their cost and price; the State and local taxation falls chiefly upon lands, and houses, but largely also upon licences to trade, hence it enhances the prices of both rents and commodities. Two thousand five hundred millions, or two and a half billions a year, together with the profits upon it (for nobody pays a dollar in taxes without endeavoring to more than equally recoup himself) form a heavy weight upon our thirty-four billions of annual earnings, and this weight cannot have failed to enhance very materially the cost of rents, commodities and services.

SOLUTION.

The expansion of the currency, its increased influence upon prices due to velocity, and its varied enhancement of the different classes of commodities and services, such as stocks, staples, fabrics, real-estate, etc., enhancing certain of these classes more rapidly than others, due to precession, have already been shown. To estimate these dynamic influences in statical figures is impracticable; we can only claim generally that they are very considerable, and that together with the influence of an enormously expensive system of governments, Federal, State and local, they appear to be the only causes of a magnitude commensurate with the colossal nature of the problem.

THE FUTURE.

In relation to the productive, economical and fiscal operations of a great country, especially with those of the newest, the most extensive, and the most powerful State in the world, whose economic policy is necessarily subject to much experiment and change, it is extremely hazardous to predict. But if we permit our judgment to be guided by three or four great lines of national figures, which, ever since the foundation of the Republic, have exhibited a constant though not uniform rate of increment, the future level of prices, concretely the future cost of living, unless modified by a radical change of fiscal policy, seems almost inevitably bound to rise still farther. These lines of figures represent the steady growth of population; the steady growth of productive capacity; the steady increase of circulating money and the increase of the transporting facilities and credit devices which enhance its velocity; and the recent and enormous increases of taxation (federal, state and local,) which, from something less than one billion in 1897, has now reached two-and-a-half billions and is still pointing upward.

The future, as indicated by these lines, points to still higher prices. Nor can we regard such further rise as likely to be materially retarded by any of the otherwise laudable and well-meant acts of legislation which have been lately secured by our public men and representatives.

EDITORIAL COMMENT

The U. S. Bureau of Mines.

As the creation of a Bureau of Mines under the Department of the Interior of the United States is an accomplished fact, any critical examination into the necessity for its existence might seem to be useless. In the judgment of most excellent authority, however, the bill by which the Bureau was created does not clearly define the plan nor scope of the Bureau itself nor the duties of its director. If as director is chosen a broad-minded man of technical training, who discerns clearly the policy under which the Bureau can do the most good, and who solves correctly the difficult problem of making the work under him co-ordinate and co-operative with that of the United States Geological Survey, the handicap of the political origin and character of the Bureau may be in a measure overcome. There is, therefore, still an opportunity for useful service in attracting the best professional interest in the country to the situation as it exists, and in inviting the expression of influential professional opinion, so that those who are to direct the work of the Bureau may see clearly the trend of thought among American mining men and take it into account in the establishment of their policies.

So far, one of the first and most perplexing facts connected with the movement is the extremely small part, if any, that has been taken by representative mining men, responsible mining interests, or the representatives of distinctive mining States, in the demand for the establishment of the Bureau, and the extremely small body of opinion, if any, among leading mining men affirmative of the *raison d'être* for the Bureau, now that it is here. The United States Geological Survey for years has been doing remarkable work in the only directions in which it seems possible for the Bureau of Mines to become active. The members of the Survey for the most part are men of high-grade technical training—such men as Emmons, Langren, Irving and Cross. Because of the high professional regard in which they are held by mine owners and managers, and because of the essentially scientific (as distinguished from political) purpose and temper of the Survey, its representatives have been given free access in their investigations of the mines of the United States, whether these investigations referred to geology, product, methods, or statistics. By their personal and professional character they have placed the work of the Survey on a high plane, and their publications have built up a reputation reflecting great credit upon the Survey and the Government. It is a matter of serious doubt whether mine owners and managers will be equally willing to afford to the members of this new Bureau (whose purposes are distinctively administrative, regulative, apparently a part of the inquisitorial and hostile attitude toward corporations which is now so popular) the freedom of access and investigation so readily given to the Technologic Branch of the Survey, by which the Government has been enabled to collect and distribute an enormous body of interesting data and statistics on the mining industry of the United States.

The bill by which the Bureau of Mines is created indicates as its principal purpose the prevention of accidents in mines. By far the most important function of the Bureau, therefore, will be the collection of such data and statistics as will guide the legislators to pass laws designed to secure the prevention of casualties and fatalities, especially in coal mining. As it is now generally accepted that these accidents are traceable to certain conditions underground, which must be determined by the investigation of thoroughly trained scientists, capable of devising ventilation and other methods which will prevent explosions of gas or dust, it seems plain that the Geological Survey with its existing equipment has been working along the right lines. It is only, therefore, by bringing out the facts regarding mine explosions and mine accidents that anything can be accomplished by the Bureau; and the collection of these facts and statistics has long been done and is now being done most satisfactorily by the Survey.

It is very doubtful, therefore, whether the Bureau of Mines can do the work as well as the Survey has done it, except after many years of experience, or unless the two departments are drawn so closely together as to be practically under one head. But the bill itself divorces these two departments of the Government, and from its tone tends to convey the idea that they are to be completely separate, inasmuch as it specifically takes away from the Geological Survey certain "plant" which it is now using and turns over to the Bureau of Mines "such experts, employees, property and equipment as are now employed or used by the Geological Survey in connection with the subjects herein transferred."

Furthermore, a Bureau of Mines, which, as the bill expresses it, has to do with the methods of mining, especially with the safety of miners, is very likely to be accorded no more facilities than it can legally demand. It does not appear that it can accomplish anything, even in the direction sugested by the bill, that is not already achieved by the Survey. It does appear that as representing an administrative department of the Government and not a scientific one, its investigations will arouse a spirit of antagonism. And if reliance is placed upon statutory powers to obtain by force of authority that which will not be given it willingly, it seems that the objection advanced by Senator Root will certainly present itself—that is, that the Federal jurisdiction will be very small, the matters for the most part being subject to State and not Federal control; that the States will see in this Federal undertaking a duplication of the work already done by themselves; that they will not co-operate with the Bureau as they do with the purely scientific work of the Geological Survey; and that they will consider this undertaking by the general government an infringement of State rights.

These, then, are believed by well-informed men to be some of the difficulties which the Bureau will have to overcome—difficulties great enough to justify fully the suggestion hereinbefore made, that the directorship demands a high order of talent and a strong and efficient personality. Beyond these difficulties lie the problems of segregating the work of the Bureau from that of the Survey and still harmonizing both branches. And beyond that once more lie the difficulties of securing proper appropriations from Congress—difficulties from which the Survey has always suffered, but in spite of which its admirable work has been carried on. As the simpler course of strengthening the influence and enlarging the resources of the United States Geological Survey has not been adopted, but instead the machinery has been in part duplicated, and, it is to be feared, still more complicated by the creation of this new and anomalous institution, the Bureau of Mines, it rests with the wisdom of its director-to-be to make his fifth wheel as serviceable to the cause of progress as its somewhat unpromising nature and origin will permit.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE BRITISH RAILWAY SITUATION.

A SUMMARY OF THE INDICATIONS OF THE IMMINENCE OF GOVERNMENT OWNERSHIP AND THEIR LESSONS FOR THE UNITED STATES.

Engineering News.

W M. ACWORTH, one of the best posted railway men in Great Britain, in a paper contributed to the *Bulletin of the International Railway Congress* for February, examines the railway situation in Great Britain and finds many indications that great and fundamental changes impend. "The old edifice of the English railway system," he says, "is tottering to its fall, and no one yet knows what will take its place. The old system was one that relied almost wholly on private enterprise, the force of competition, that reduced state interference to a minimum, and, indeed, in the matter of facilities and public service practically excluded state interference altogether. This system is passing away. In the proximate future we shall have to choose between state-regulated monopoly or, as to me seems much more probable, state ownership and state operation."

Mr. Acworth's paper is reprinted in full in *Engineering News* for May 19. An editorial in the same number, from which we quote at length below, summarizes his arguments and indicates the lessons which the railways of the United States may learn from the present situation in Great Britain. It is pointed out that "the railway system of the United States is patterned closely after that of Great Britain. In the other great nations—Germany, France, Russia, Austria—government ownership of railways is the rule. Government ownership is the rule, too, in most of the minor countries; and in some countries which have not adopted government ownership, the Government is actually closely concerned with railway operations through the grant of government subsidies. It is, broadly speaking, true, therefore, that Great Britain and the United States are the only two great nations of the world which have developed their railway systems by private enterprise alone and which have never in any degree adopted government ownership of railways.

"In both England and the United States, government supervision of railway operation has been steadily increasing during the past quarter century. In England, however, competition in railway transportation has been maintained to a much greater extent than in the United States, and has been a chief reliance in securing for the public reasonable rates and efficient service. But there is now impending in England an era of consolidation and combination which promises to put an end to competition. To appreciate the importance of Mr. Acworth's statement quoted above, it should be understood that Mr. Acworth is not only one of the best informed men in British railway circles, but is and always has been one of the strongest advocates of private railway management as opposed to government ownership or control.

"The causes which have brought about this impending change in the British railway situation are fully set forth by Mr. Acworth. Briefly summarized, British railway managers are between the devil and the deep sea. On the one hand, their employees demand better wages and better conditions. In 1907, under the imminent prospect of a general railway strike covering the entire country, the railway managers were obliged to submit to arbitration questions relative to wages and hours of labor. On the other hand, there is strong complaint from freight shippers that the rates charged are too high, and strong pressure has been exerted through the British Board of Trade to bring about a reduction. And with this pressure to increase expenses and reduce earnings comes vigorous complaint from shareholders, who complain of scanty profits and low rates of dividend. Under the stress of this situation, competition in the railway business, so long maintained in England, broke down. Combinations were arranged between the different great railway companies which would have assembled all the lines into three or four non-competitive groups. It was hoped by this plan to reduce the heavy expenses caused by competition and thus enable the companies better to meet the demands of employees, shippers and stockholders. But when the sanction of the Government was sought for these combinations, great public protest was made and the desired consent was refused. Actual consolidation, therefore, could not be carried out; but a similar end could be and has been attained through private agreement. As Mr. Acworth tersely puts it, 'competition in fact is dead, and not all the king's horses nor all the king's men can bring it to life again.' With competition ended, as a force in securing to the public good service at reasonable rates, it is undoubtedly true that England must choose between a long step forward in government control of railway operations and the adoption of state ownership and state operation.

"Turning, now, to the situation in the United States, it is probably true that the general public at present regards government ownership of railways as a mere dream of the theorist. While such a policy might perhaps find considerable popular support, the business community undoubtedly would almost unanimously oppose it. But how long is the public likely to retain this position? We cannot safely shut our eyes to what is going on about us in other countries of the world. Within the past two years, Japan and Mexico have each undertaken the complete nationalization of their railway systems. Unquestionably the tendency is in this direction, the world over. If Great Britain should take the step which Mr. Acworth declares to be probable, the United States would be left as the only country in the world having its railway system entirely under private management.

"It is of interest to inquire as to the causes which have brought British railways into the unfortunate situation which Mr. Acworth describes. It is a historical fact that when George Stephenson's great success with the locomotive inaugurated the railway era, the railway was regarded as chiefly a means of passenger transportation. The early railway promoters had no idea of competing with the canals in the carriage of coal and other low-class freights. their ideas were directed solely toward the carriage of passengers at high speeds. The railway system of England, which was developed earlier than that of any other country, was particularly planned and has always been particularly operated, with passenger traffic as its main object. English railway men appear to have been slower than those of other countries to appreciate the fact that freight traffic rather than passenger traffic was the business paying greatest profits.

"In the profitable handling of passenger traffic, moreover, English railways have always been hampered by the great handicap of the class system. The necessity of providing first, second and third-class accommodations in practically every passenger train was modified only a few years ago by the abolition of the second class on most English railways. The first-class and third-class, however, still continue in use everywhere. The system of classing passenger traffic, in conjunction with the use of the compartment system for passenger cars, makes it exceedingly difficult to load passenger trains to anything like their capacity. A large proportion of English passenger trains run with their seats not one-third filled. More important than this, in its effect on operating expenses, however, is the great number of station men which are necessary on account of the compartment system. While the wages of these men are very low according to our American standards, the number of employees is so great that the burden upon railway operating expenses is extremely heavy. It will be admitted, of course, that the English system of handling passengers is so imbedded as one of the customs of the country that any radical change would be extremely difficult. Nevertheless, it is apparent that reduction of operating expenses is one of the first essentials to placing English railways on a proper financial basis, and the most direct means of reducing operating expenses is reduction in the number of trains and in the number of employees.

"The second great handicap under which English railway companies labor is their enormous capitalization. Fortunately, this capitalization is in stock or debenture securities not subject to foreclosure. English railways, therefore, do not have to meet interest on mortgage bonds under the penalty of going into a receiver's hands. What does face them is general dissatisfaction on the part of their security holders because of the low rates of dividend. Under present conditions, however, net earnings would have to be very largely increased to raise materially the rate of return to holders of railway securities, because the capitalization per mile is so heavy. The average capitalization of all the railways of Great Britain is about $270,000 per mile, which compares with about $75,000 per mile in the United States.

"There are several reasons for the high capitalization of British railways. The first is the high class construction which has prevailed everywhere in England since the earliest days of the railway era. More important than this, however, is the very heavy expense which the railways were under to obtain terminal facilities in the cities which they entered. Ranking almost on a par with this are the very heavy parliamentary and legal expenses with which the railway companies were burdened in securing their franchises. Besides all these, the policy has always been in Great Britain to charge all expenditures on improvements to capital account. Where American railways have devoted a certain proportion of their earnings to betterment British railways have conscientiously capitalized every expenditure which could not be classed as repair or maintenance. As a consequence, their capital has gone on rolling up like a huge snowball until the present stupendous figures have been attained.

"While such a system of capitalizing expenditures on betterments may have a theoretical justification, it is inherently unsound. Take, for example, the very large fees paid to the experts who appeared before Parliament in obtaining the charters of some of the early railway lines. Because a company paid $50,000 to Robert Stephenson for his testimony before a Parliamentary committee 75 years ago, is it reasonable that the public should go on paying interest on that expenditure, not only for the 75 years that have elapsed since, but for untold centuries to come? Does not any such system of capitalization tend to break down by its own weight? Ought not a certain proportion of earnings to be annually set aside for the retirement of capital, or, what amounts to the same thing, for expenditure upon betterments, instead of charging them to capital account?

"It has seemed to us important to call attention to this situation with respect to the railways of England because of the temptations now present to the railways of our country to repeat the same mistakes here that have been made there. American railway companies during the past ten years have been increasing their capitalization in a manner wholly unprecedented. Improvements of all sorts are paid for with a lavish hand so long as Wall street will purchase stocks or bonds and when these are unsalable, short-term notes are resorted to. Wherever the improvements to be made with this money will actually pay for themselves in the shape of reduced expense of operation or increased earnings, such added capitalization is, of course, justifiable, but if the secrets of all hearts were revealed, we fear that no small proportion of this added capital would be found invested in directions which promise small returns in the way of revenue and which will benefit the banking interests in control rather than the stockholders of the present or future.

"We believe that in many respects the railway system of the United States under private management, and with the benefit of private initiative, is superior to the railway system of any other country. But if we are to continue to have these benefits—if the United States is not eventually to follow the example of all other nations by adopting government ownership for its railway system—then our railway magnates must realize their trusteeship in the largest sense. They must be willing to learn from the experience of other countries; they must be as ready to recognize the rights of the public and of their employees as they are to see the opportunities to make fortunes through the promotion of big deals and a vast outlay of money in extensions."

CONCRETE BARGES ON THE PANAMA CANAL.

DETAILS OF THE DESIGN AND CONSTRUCTION OF THREE REINFORCED-CONCRETE BARGES FOR THE SUPPORT OF DREDGING PUMPS.

Engineering Record.

OUR issue for May of last year contained a brief description of reinforced-concrete barges and pontoons built in Italy by the pioneers in this branch of naval construction. While reinforced concrete has been applied to this purpose only in isolated cases, builders and users of concrete barges are agreed that the material lends itself well to this new use and, under certain conditions, is superior to wood or steel. A combination of circumstances recently led to the adoption of reinforced concrete for the construction of three barges for the support of dredging pumps on the Pacific Division of the Panama Canal. The barges had to be ready for service at short notice, and neither materials nor men were available for their construction in wood or steel. The cost of material for one barge was estimated at $1,065.80, which compared favorably with the cost of any other barge of the size desired. The results obtained with the first barge, which was launched on April 19 last, 60 days after the commencement of work, have amply justified the choice of material.

A description of the design and construction of this barge is given in *Engineering Record* for May 28. "It is rectangular in plan, 64 feet long, 24 feet wide, and has a 7-foot rake at the bow and stern to facilitate towing. The bottom is flat, while the deck has a sheer lengthwise of 4 inches and 1-inch crown crosswise, so that the depth of the hull varies from 5 feet 4 inches to 5 feet 8 inches.

"Two bulkheads, 3 inches thick and spaced 8 feet on centers, extend from bow to stern, forming, with the 2½-inch side walls, three equal compartments. The bulkheads and side walls, stiffened at intervals of 10 feet by posts 10 inches quare, are each to be considered as the veb of a girder, whose chords are ormed by a line of longitudinal 10 and 1½-inch beams in the deck and floor of the barge respectively. At the posts, he top and bottom chords of the girders re cross-connected by 10 and 11½-nch beams with heavy kneebraces. The ystem of beams subdivides the deck and ottom into 8 by 10-foot panels, which re covered by 3-inch and 2½-inch slabs espectively.

The following reinforcement is being sed.: In the bottom slab, ½-inch mesh No. 12 wire cloth and ½-inch square ars, spaced 12 inches on centers crossvise and 9 inches lengthwise. The same einforcement is used in the 2½-inch ide walls. In the deck ½-inch square ars are spaced 8 inches crosswise and 6 inches lengthwise. Deck and bottom eams have the same reinforcement, iz.: three ¾-inch square bars on the ension side, one of which is bent up at he quarter points and carried over the upports. The posts are reinforced by our ¾-inch square bars, 2 inches from he corners, the kneebraces by two ½-nch bars, while ½-inch square bars are laced vertically and spaced 8 inches on enters on the longitudinal bulkheads.

“Six round 21-inch hatches are provided, one at each end of the three compartments, to give access to, and allow nspection and ventilation of, the interior. Wherever a hatch is located, the lab is strengthened by an additional mall beam. Near each corner of the leck a mooring bit is anchored by six ¾-inch countersunk bolts through the lab to a heavy washer plate. A 12 by 6-inch timber fender is fastened flush vith the deck to the sides and ends of he boat.” The total of the dead and ive loads is 288,500 pounds. The displacement light is 3,678 cubic feet, and oaded, 4,624 cubic feet, making the lraft of the barge light, 2 feet 9 inches, and loaded, 3 feet 5 inches.

In building the barge, “a platform was built on cribbing with enough height underneath for men to work and to build he ways for launching. On this platform heets of wire cloth are laid crosswise and bent up so as to extend the total height of the side walls. The sheets are 36 inches wide and are securely tied together where they butt in the length direction of the barge. On this wire cloth are tied the bars that form the reinforcement of the bottom. The cross-bars are made up of one piece 14 feet and one 22 feet long, spliced by overlapping 1 foot, the splice being alternately under the port and starboard length girder. Five feet at each end of these bars are bent up and form the reinforcement of the sides. The longitudinal bars consist of 21-foot pieces, spliced at every second cross-beam by overlapping 1 foot; the splices are staggered. At the ends of the barge these bars are bent up to conform to the outline of the rakes. The arrangement of the longitudinal bars in the side walls is similar. At the center lines of all beams stirrups are hooked to the main bars; they are 5/16-inch rods, spaced 9 inches on centers for the longitudinals and 12 inches for the cross-beams.

“The concrete shell is formed by plastering the steel skeleton. For that purpose the reinforcement is suspended on wooden beams, sections 10 by 24 feet at a time, and the sheeting of the platform is removed. The plaster can be applied from the outside and pressed well into the wire mesh. As soon as the initial set takes place a high finish is given to the lower face, and finally, the supporting platform is put back in place. The progress is so arranged that a day’s work ends under a line of cross-beams and takes in the whole width of the bottom. After this first coating, about ½ inch thick, has set for three days, the plastering of the inside is started. Here the joint between two days’ work is located half way between two lines of cross-beams. The plastering of the sides is performed in a similar manner. To make the mortar set faster, thereby facilitating the plastering, and to produce a denser mixture, one-quarter of the cement has been replaced by lime.

“Next the forms for floor-beams are erected, and the steel for floor-beams, posts, kneebraces and bulkhead placed. This done, the floor-beams can be concreted. Then the forms for posts, bulkheads, deck beams and deck slabs are put up, the beam and slab reinforcement laid and tied. The longitudinal bars in the deck are 21 feet long, and have their splices arranged like the bars in the floor; the cross-bars are 26 feet long and have 14 inches at each end bent down into the side wall. In laying concrete a day's work is stopped for the beams, in the middle of a span; and for the slabs, at the center line of a beam.

"All forms were built in sections, the pieces being small enough to pass through the hatches, and the same forms will be used for all three barges. From the start, concrete was protected by heavy canvas against the hot sun, and was kept moist by sprinkling with a hose."

THE CHOICE OF MOTORS FOR MACHINE TOOLS.

A SUMMARY OF STANDARD PRACTICE IN THE SELECTION OF ELECTRIC MOTORS FOR MACHINE-TOOL DRIVING.

Charles Fair—American Institute of Electrical Engineers.

IN our last issue we printed in these columns a series of tables giving standard sizes and speeds of motors for driving various classes of machine tools. A useful supplement to these data will be found in the table below, taken from a recent paper by Charles Fair before the American Institute of Electrical Engineers and printed in the *Proceedings* for May, which summarizes standard practice in the choice of the type of motor for machine-tool applications. The difficulties of selection, Mr. Fair thinks, have been greatly exaggerated. Various circumstances may call for radical departures from standard practice, but under average conditions the list given may safely be followed.

In general, shunt-wound motors are used when the work is of a fairly steady nature, when considerable range of speed adjustment is required, on group and lineshaft drives, etc. Compound-wound motors are used where there are sudden calls for excessive power of short duration. Series motors should be applied where speed regulation is not essential and where excessive starting torque and low starting speeds are required.

The alternating current motor of the squirrel-cage rotor type corresponds to the constant-speed, shunt, direct-current motor, but with a high-resistance rotor it approaches more closely the characteristics of a compound direct current motor. The variable speed machines, placed in the list under the alternating current squirrel-cage rotor column, are understood to have the necessary mechanical speed changes. The slip-ring induction motor with external rotor resistance would be used for variable speed, not as corresponding to the direct-current adjustable-speed motor, but to the direct-current shunt motor with armature control. The self-contained, rotor-resistance type would be used for lineshaft drives and for groups of sufficient size.

Mr. Fair is emphatic as to the choice of standard motors. "One of the most important features in the selection of motors and one that is persistently overlooked," he says, "is the strict adherence to the use of standard motors, and by standard motors is meant standard armature shafts as well. The importance of maintaining standard armature shafts will be readily recognized by the factory management when it is pointed out that by such an arrangement spare armatures are reduced to a minimum, and that in an emergency it is possible, where these are not carried, to replace an armature or even a whole motor, from an idle tool, or from a tool of relatively less importance at the time. Also, of course, stock motors can be supplied promptly by the manufacturer and shipments materially improved if special shaft extensions are not called for. That special features in a motor are sometimes desirable, is not to be denied; it may so happen that the ad

MOTORS FOR MACHINE TOOLS.

Tool.	Direct current.			Alternating current.		
	Shunt.	Compound.	Series.	×	#	*
Bolt cutter	†			×		
Bolt and rivet header		40 per cent.				
Bulldozers		20 per cent.		×	#	
		40 per cent.			#	
		20 per cent.		×	#	
Boring machines	†			×		
Boring mills	†			×		
Raising and lowering cross rails on boring mills and planers		60 per cent.	†		#	
Boring bars	†			×		
Bending machines		20 per cent.		×	#	
		40 per cent.				
Bending rolls		40 per cent.	†			*
		80 per cent.				
Corrugating rolls		20 per cent.		×	#	
		40 per cent.				
Centering machines	†			×		
Chucking machines	†			×		
Boring, milling and drilling machines	†			×		
Drill, radial	†			×		
Drill press	†			×		
Grinder—tool, etc.	†			×		
Grinder—castings		20 per cent.		×		
Gear cutters	†	20 per cent.		×		
Hammers—drop		20 per cent.			#	
		30 per cent.				
Keyseater milling broach	†			×		
Keyseater—reciprocating	†	20 per cent.		×		
Lathes	†			×		*✠
Lathe carriages			†		#	
Milling machines	†			×		
Heavy slab milling	†	20 per cent.		×		
Pipe cutters	†			×		
Punch presses		20 per cent.		×	#	
		40 per cent.				
Planers		20 per cent.		×		
Planers—rotary	†	20 per cent.		×		
Saw—small circular	†			×		
Saw—cold bar and I beam	†	20 per cent.		×		
Saw—hot		20 per cent.		×		
Screw machine	†			×		
Shapers	†	20 per cent.		×		
Shears		20 per cent.		×	#	
		40 per cent.				
Slotters	†	20 per cent.		×		
Swaging		20 per cent.		×	#	
Tappers	†			×		
Tumbling barrels or mills		20 per cent.		×		

× Squirrel-cage rotor.
Squirrel-cage rotor, high starting torque.
* Slip-ring induction motor with external rotor resistance.
✠ Might be used for tire lathes, as it allows slowing down when cutting hard spots.

vantages from some special feature in the motor may more than offset the disadvantages above referred to, but in cases where these special features are thought necessary they should be carefully considered before a final decision is made."

THE COST OF ELECTRIC POWER IN NEW YORK CITY.

AN ANALYSIS OF THE GENERATION AND DISTRIBUTION COSTS OF TWO LARGE POWER COMPANIES FOR THE YEAR ENDING JUNE 30, 1907.

Engineering-Contracting.

THE tables following, which are compiled from two articles published in *Engineering-Contracting* for April 6 and May 11, give authoritative unit costs of generating and distributing electricity for power and lighting in the plants of the Edison Electric Illuminating Company of Brooklyn and the New York Edison Company during the fiscal year ending June 30, 1907. The New York Edison Company produces nearly 70 per cent. of the electricity used for lighting in New York City and the Brooklyn company is by far the most important operating in the city, next to the New York Edison Company. The com-

Generation and Distribution Equipment.

Station Equipment.

	Brooklyn.		New York.	
	Number.	Capacity.	Number.	Capacity.
Generating plants	1	23,650 kw.	8	108,300 kw.
Boilers, water tube	40	23,400 hp.	144	76,382 hp.
Superheaters	8	6,000 hp.	45	29,250 hp.
Steam engines, direct connected	5	14,750 hp.	30	82,900 hp.
Steam engines, belted	..	....	5	1,725 hp.
Turbo-units, direct current	2	11,250 kw.	.	....
Turbo-units, alternating current	..	....	9	53,500 kw.
Generators, direct connected, a. c.	5	12,400 kw.	21	93,000 kw.
Generators, direct connected, d. c.	..	....	34	14,100 kw.
Generators, belted, a. c.	..	....	3	900 kw.
Generators, belted, d. c.	..	....	2	300 kw.
Boosters	1	50 kw.	..	....
Exciters, motor-driven	2	250 kw.	10	1,400 kw.
Exciters, steam-driven	2	1,000 kw.	3	225 kw.
Storage battery cells	222	5,120 ah.	2x140	12,000 ah.
Rotaries	1	1,000 kw.	..	....
Transformers	3	1,200 kw.	2	2,500 kw.
Frequency changers	..	....	1	1,000 kw.

Substation Equipment.

	Brooklyn.		New York.	
	Number.	Capacity.	Number.	Capacity.
Substations	..	....	23	93,750 kw.
Rotary converters, etc.	63	29,600 kw.	100	93,750 kw.
Transformers	156	43,500 kw.	276	108,735 kw.
Storage battery cells	1,200	18,875 ah.	32x150	192,000 ah.
Balancers	7	450 kw.	..	....
Boosters	13	650 kw.	..	....
Motor generators	31	8,045 kw.	..	....

Cost of the Brooklyn Plant.

	Total.	Per kilowatt.
Generating station buildings and land	$ 674,666	$ 29
Substation buildings and land.	650,559	28
Other real estate	48,007	2
Steam plant, generating station	1,051,796	44
Electrical plant, generation station	965,824	41
Substation apparatus	507,965	21
Transmission lines	4,136,009	175
Construction, subways	230,950	10
Services	973,558	41
Line transformers	150,184	6
Meters	301,677	13
Arc lamps	242,607	10
Tools and implements	20,955	1
Office furniture and fixtures	50,131	2
Miscellaneous appliances	64,874	3
Storage batteries	182,150	8
Sundries, automobiles, etc.	74,526	3
Total	$10,326,437	$137

bined capacities of the plants of the two companies aggregate nearly 132,000 kilowatts.

Meter, Lamp, Conduit, and Wire Equipment.

	Brooklyn.	NewYork.
Meters owned	18,088	74,169
Meters in service	16,011	70,533
Lamps owned:		
A. C. enclosed arc	577	1,957
D. C. enclosed arc	6,352	13,806
D. C. open arc	1,174	...
Nernst	2,711	1,813
Glowers	...	6,522
Lamps in service, arc	...	34,531
Lamps in service, incandescent	...	2,665,085
Conduits owned, duct feet	3,039,132	...
Conduits occupied:		
Duct feet occupied	2,355,177	4,461,600
Feet of circuit, d. c.	1,495,057	10,183,000
Feet of circuit, a. c.	810,354	1,000,000
Million mil. feet of wire, d. c.	1,558,042	4,619,000
Million mil. feet of wire, a. c.	472,781	179,000
Overhead lines:		
Feet of circuit, d. c.	918,348	...
Feet of circuit, a. c.	513,892	1,096,000
Million mil. feet of wire, d. c.	81,125	...
Million mil. feet of wire, a. c.	86,443	794,000
Feet of street occupied	875,918	639,735

Production and Sale of Current.

	Brooklyn.	New York.
Kilowatt-hours produced	71,769,804	299,172,431
Kilowatt-hours used in station	800,783	....
Kilowatt-hours sold	[illegible]	[illegible]
Average load factor	34.7 per cent.	31.5 per cent.
Transmission losses, etc.	32.5 per cent.	30 per cent.
Average sale price, cents per kw. hour	6.6	6.49

The total first cost and the first cost per kilowatt of rated capacity of the Brooklyn plant are given in the tables. No exact figures of the cost of the New York plant are available, but the records show that $43,417,883 of bonds have been issued. This probably represents the actual engine cost, about $400 per kilowatt. It is possible that additions, paid for out of earnings, have increased the cost to $500 per kilowatt. The cost of the United Electric Light and Power Company's plant in New York, comprising four generating stations with a combined capacity of 10,200 kilowatts, was $523 per kilowatt.

The tables give unit cost per kilowatt-hour produced. The costs per kilo-

COST OF POWER GENERATION AND DISTRIBUTION.

PRODUCTION EXPENSE.

	Brooklyn.		New York.	
	Total.	Cents per kw.-hour.	Total.	Cents per kw. hour.
Salaries	$22,510	0.031	$35,908	0.012
Labor	136,116	0.190	508,778	0.171
Fuel	285,654	0.400	1,210,599	0.406
Oil, waste and sundries	17,355	0.024	54,565	0.018
Water	28,449	0.039	135,211	0.045
Repairs, buildings and structures	2,493	0.003	37,435	0.012
Repairs, motive power	39,622	0.056	211,175	0.070
Repairs, electrical apparatus	2,296	0.003	22,634	0.007
Station expense	2,330	0.003	24,893	0.008
Purchased power, electric	28,575	0.039	75,220	0.025
Total production expense	$565,400	0.788	$2,316,418	0.774

DISTRIBUTION EXPENSE.

Salaries	$7,687	0.011	$64,146	0.021
Substation labor and expense	98,607	0.138	148,499	0.050
Rental of conduits, etc	117,162	0.163	1,014,081	0.339
Incandescent lamp renewals	110,199	0.153	538,213	0.147
Wiring and jobbing	......	....	139,713	0.047
Repairs, poles and lines	22,918	0.032	21,716	0.007
Repairs, subways and cables	30,957	0.043	56,856	0.019
Repairs, meters	4,872	0.007	221,894	0.074
Repairs, transformers	187	....	......	....
Repairs, substations	......	....	202,611	0.068
Repairs and expense, commercial lamps	89,711	0.125	12,872	0.004
Repairs and expense, street lamps	......	....	68,096	0.023
Total distribution expense	$482,300	0.672	$2,388,698	0.799

GENERAL EXPENSE.

Salaries of officers	$18,850	0.029	$51,241	0.017
Salaries of office staff	67,665	0.094	335,825	0.113
Collecting and reading meters	19,797	0.028	......	....
Office expense	......	....	294,009	0.098
Legal expense	19,009	0.027	116,630	0.039
General expense	73,256	0.101	......	....
Advertising and soliciting	......	....	218,850	0.073
Advertising	44,364	0.061	......	....
Canvassing new business	82,917	0.115	......	....
Insurance	47,884	0.067	118,393	0.040
Engineering and testing	......	....	78,707	0.026
Leaseholds, rentals, etc	......	....	47,656	0.016
Miscellaneous	58,178	0.080	......	....
Total general expense	$431,920	0.602	$1,262,311	0.422
Taxes, general	$86,916	0.121	$702,628	0.235
State franchise tax	61,584	0.085	......	....
Leaseholds, rentals, etc	4,783	0.007	......	....
Uncollectable bills	......	....	35,464	0.011
Depreciation and contingent expense	......	....	1,721,413	0.575
Grand total	$1,632,903	2.275	$8,425,933	2.816

watt-hour sold in Brooklyn and New York were, respectively, 3.37 cents and 4.04 cents. The costs of repairs per kilowatt of rated capacity in the Brooklyn and New York plants were, respectively, $4.36 and $8.37 exclusive of lamp renewals, and $12.80 and $12.83 including lamp renewals. Allowing 4 per cent. of the first cost of the Brooklyn plant for depreciation and 6 per cent. for interest on the invested capital, the cost per kilowatt-hour sold becomes 5.498 cents. The average selling price was 6.6 cents per kilowatt-hour; hence the net profit was at least 1.1 cent per kilowatt-hour. Interest at 6 per cent. added to the cost per kilowatt-hour in the New York plant increases it to 5.60 cents. At an average selling price of 6.49 cents, the net profit was nearly 0.9 cents per kilowatt-hour.

The employees of the New York company numbered 4,014 and their average wage was $16.40 per week. The average wage of the 1,454 employees in Brooklyn was $13.50 per week. The coal burned in both plants was nearly all anthracite of a very low grade. Coal consumption per kilowatt-hour was 4.30 pounds in Brooklyn and 4.11 pounds in New York. The average prices of the fuel in the two plants were, respectively, $1.60 and $1.96 per ton of 2,000 pounds.

MODERN METHODS OF LIGHTNING PROTECTION.

A BRIEF REVIEW OF METHODS AND APPARATUS FOR THE PROTECTION OF LINE AND STATION EQUIPMENT.

Charles P. Steinmetz—The Central Station.

PROTECTION of electrical systems against the disturbances produced by atmospheric electricity and internal phenomena of the same nature has become almost wholly an economic problem. Modern science has elucidated the causes of the troubles which were once the despair of the electrical engineer and has provided methods and apparatus by which it is possible perfectly to protect an electrical system against lightning. With adequate means of protection at hand, the engineer of to-day has only to balance the increased cost of installation and operation of the system equipped with lightning protection against the higher order of reliability which the protection confers. Reliability of service, however, as a factor in successful operation, has increased rapidly in importance with the extension of transmission systems to cover larger and larger areas and to transmit currents of higher and higher tension, and the protection of systems against lightning disturbances is in most cases a matter of considerable moment.

Dr. Charles P. Steinmetz has given in *The Central Station* for May a brief review of the modern methods and apparatus for the protection of line and station equipment against both external and internal lightning. External or atmospheric lightning is almost always momentary, a single high-voltage impulse or a few impulses in very rapid succession. Internal lightning is frequently continuous, high-voltage impulses following each other in rapid succession sometimes for hours or even days. Momentary high voltage impulses are produced externally when lightning strikes the line or occurs sufficiently close to induce in the line a voltage impulse; internally they may result from switching operations, short circuits, sudden change of load, etc. A stroke of atmospheric lightning, depending on its power, may shatter several poles and insulators or merely run along the line as a wave of rapidly decreasing intensity. Momentary internal lightning is rarely of serious danger because of the protection which modern switching and other apparatus, designed to reduce shock to a minimum, give the system. The most frequent causes of continuous lightning, in which much more danger lies, are arcing grounds, flaring arcs, spark discharges, etc., in cable systems or high-voltage overhead lines of considerable capacity.

The problem of lightning protection involves both line and station apparatus. External lightning may be excluded from the system by protection of the lines, through which it almost always enters the system. Internal lightning may originate in the lines as well as in the station apparatus. Theoretically complete protection of an overhead line against the entrance of atmospheric disturbances may be obtained by enclosing the line in a grounded shell of high conductivity. An approximation to this protection is afforded by an overhead ground wire of good conductivity, carried above the line wires at such height as to bring the line wires at least 45 degrees below the ground wire and grounded preferably at every pole. Frequency of grounding is of far greater importance than low resistance.

The protection afforded by the ground wire will practically always warrant the additional expenditure required to instal it, except in systems where reliability is of no importance or in regions where thunderstorms are of very rare occurrence. Additional protection can be obtained by installing an additional ground wire on either side of the line, but such an installation is rarely warranted except in sections especially exposed to lightning. Where a ground wire is used, it is desirable to supplement it by a short lightning rod at each pole. Lightning rods at each pole are occasionally used in place of the ground wire. While they offer some protection against direct strokes, they are practically no protection against induced discharges from the clouds. The installation of a lightning rod every five or ten poles offers no protection whatever.

The most effective line protection is afforded by construction with a very high margin of safety, readily obtained by the use of the suspension insulator, the invention of which marked a distinct and important advance in high-tension line construction. Lines equipped with this device have been remarkably free from lightning troubles, even when not protected with ground wires.

Disturbances in the line produced by lightning rapidly diminish as they pass along the line. The farther away from the station the disturbance enters the line, the less danger it offers to the station equipment. Hence, in cases where overhead ground wires are not used over the entire line, some improvement in station protection results from covering the line for one-half mile to one mile from the station with ground wires. The final protection of the apparatus in the station, however, must be left to the station lightning arrester.

"The requirements of the lightning arrester are, that it afford a path from the line to ground at moderate over voltage, that this path be of unlimited discharge capacity, that is, afford no appreciable resistance or inductance to the discharge, and that the discharge shall not result in any disturbance of the system, which might cause high voltages and thereby damage elsewhere, and should not produce a short circuit on the system. The latter two requirements are apparently contradictory: the lightning arrester should freely pass the lightning discharge, but should not pass the main current, which tends to follow the discharge as short circuit, and the difficulty of the problem of lightning-arrester design consists in combining these latter two requirements.

"The three existing types of lightning arrester are the single gap, the multigap, and the aluminium cell. The single gap is very largely used in low-voltage circuits, combined with a blow-out magnet in direct-current railway circuits. Sometimes it contains a mechanical device to open the gap after the discharge. The latter obviously has the disadvantage that, if a second discharge follows immediately after the first, it may find the arrester gap still opened, and the protection thereby absent. In high-voltage circuits the single gap is always developed as a horn gap; that is, the two terminals are curved back so that the arc, rising between them, lengthens and thereby gradually blows itself out. The horn gap has the advantage of simplicity, but the disadvantage, when used without resistance in series thereto, that it short circuits the system for an appreciable time, sufficiently long to throw all synchronous apparatus out of step and frequently have the generators break synchronism, and its discharge in large alternating systems thus commonly results in a shut down. Furthermore, a long flaring arc is extremely vicious, as it produces high-frequency, high-voltage oscillations, so-called internal lightning, and the result of its discharge thus may be more disastrous than the lightning against which it attempts to protect. With a resistance in series, the line disturbance caused by the discharge is reduced, and the main current, which follows the discharge, is limited so as not to cause a short circuit. At the same time the discharge current is equally limited, and with a high-power lightning dsturbance the resistance gap fails to protect. Horn gaps therefore are rarely used as station arresters, and then only as emergency devices under conditions where a shut down is accepted as unavoidable. They must, however, never be used without resistance in cable systems, as with the high capacity of cables they produce destructive oscillations.

"The multigap in its most perfect design comprises a considerable number of small gaps in series with each other, between corrugated brass cylinders. It contains no resistance in series, and thus affords unlimited discharge capacity, but comprises several shunt resistances, usually a high resistance, a medium resistance, and a low resistance, and thereby affords a selective path, according to the power of the discharge; that is, discharges with the minimum shock on the system. The main current, following a very high power discharge over the path of no resistance, short circuits the system, but the short cirsuit lasts only up to the end of the half wave of current, and ends there: the next half wave can not pass any more without a new high-voltage discharge. Thus the multigap even at the highest discharges short circuits the system only for a part of one-half wave; that is, for such short time as not to interfere with the operation of synchronous machines, the parallel operation of generators, etc. It therefore has become the type of arrester almost universally used, especially in general distribution circuits, as the primary 2,200-volt alternating lines. For the latter, usually only two shunt resistances are used, a high one and a low one.

"The multigap affords very good protection against momentary lightning, as a single discharge or a few successive discharges. It however can not take care of continuous lightning, but when exposed to continuous lightning it is burned up. The reason for this is: the heat produced by the short circuit of the multigap during a part of a half wave, or even a few half waves in case of several successive discharges, is not so great that it could not be absorbed by the metal cylinders of the multigap and gradually dissipated. In continuous lightning, however, where hundreds or thousands of discharges follow each other per second, and every discharge produces a short circuit over the multigap for one-half wave, this amounts to a continuous short circuit over the arrester, and the heat produced by this very soon destroys it.

"To protect also against continuous lightning, as arcing grounds or other internal surges, as they are especially frequent in cable systems and high-voltage transmission lines, a lightning arrester is needed which passes the over voltage; that is, the lightning disturbance, but does not pass the main current at all. This requires an arrester of the counter-e.m.f. type, that is, an apparatus which opposes the line voltage by a counter-e.m.f. equal thereto, but permits a free path to any excess voltage. To illustrate: a 500-volt storage battery in a 500-volt direct-current circuit would accomplish this, if of negligible internal resistance; at normal voltage of 500, it would take only a very small current (the current required to keep it charged), but any voltage in excess of 500 would be short circuited. This is in general the principle on which the aluminium cell acts in direct-current as well as in alternating-current circuits; on the aluminium surfaces, which are submerged in the electrolyte, a film is formed which holds back the main voltage, but any excess voltage passes freely through it. An aluminium arrester therefore can discharge continuous lightning continuously, or at least for a sufficiently long time to find and eliminate its cause.

"The aluminium cell affords the most complete protection against all high-voltage disturbances, whether momentary or repeated. It has this disadvantage, however, that when left continuously in circuit it requires artificial cooling, and the life of the aluminium plates is still rather limited. It therefore is generally used in series with a small gap, set for a voltage a little above the line voltage. In the latter case, the aluminium arrester receives current only when the gap jumps across by an over voltage. This latter arrangement is very satisfactory, and seems to give a practically unlimited life of the aluminium plates. It has however the disadvantage that it requires systematic attention; the plates must be regularly charged, so as to retain the film which opposes the normal line voltage. When neglected for a considerable time, their protective film gradually dissolves, and a discharge over the arrester then finds a short circuit instead of a counter-e.m.f. In other words, for more complete protection, something has to be paid in the systematic attention to the protective apparatus. The usual type of high-voltage alternating aluminium arrester comprises a series of aluminium cones inside of each other. The spaces between the cones are filled with the electrolyte, and the structure immersed in oil. The number of cones required depends upon the voltage of the circuit, as each aluminium cone can hold back about 250 volts."

SULPHURIC ACID FROM COPPER SMELTER FUMES.

A DESCRIPTION OF THE NEW SULPHURIC-ACID PLANT OF THE DUCKTOWN SULPHUR, COPPER AND IRON COMPANY.

W. H. Freeland and C. W. Renwick—Engineering and Mining Journal.

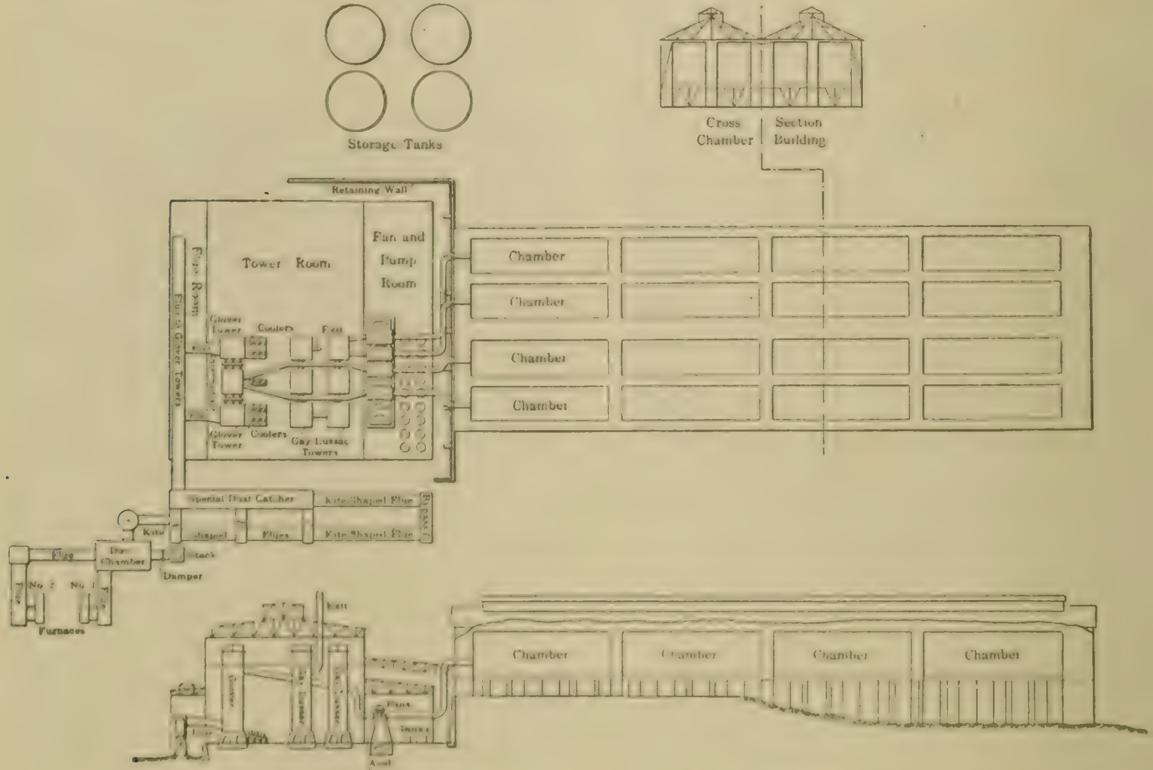
BRIEF reference was made in these columns in our issue for February, 1909, to the methods developed by the Tennessee Copper Company and the Ducktown Sulphur, Copper and Iron Company for the recovery of sulphuric acid from copper smelter fumes. The plant of the Tennessee Copper Company was placed in operation late in 1907; that of the Ducktown Sulphur, Copper and Iron Company has been opened only a little over a year. The latter installation covers a larger area than any other single undertaking of the kind in existence, and its design is an embodiment of the very latest practice in by-product copper smelting. A brief description is taken from an article by W. H. Freeland and C. W. Renwick in the *Engineering and Mining Journal* for May 28.

"The problem presented was a novel and complex one. It imposed many conditions foreign to the usual sulphuric-acid manufacturer, such as the contamination of the gases (smoke) by flue dust, unavoidable in blast furnaces; irregularities in furnace conditions and consequent fluctuations in temperature and in composition of the gases; the presence of carbon dioxide from combustion of coke (which, unfortunately, cannot be entirely dispensed with even in pyritic smelting as developed by the Company before the introduction of the acid process), and further increased by an appreciable quantity from calcium carbonate in the ore, which at furnace temperature yields lime and carbon dioxide.

"Owing to the fluctuations in composition of the gas, an average analysis would convey little idea of conditions to be met and provided for. Under fairly normal conditions the gases delivered to the chambers are approximately as follows: SO_2, 3½ per cent.; CO_2, 3½ per cent.; and SO_3, trace. The temperature of the gases in the furnace flues frequently records a range of over 200 degrees C. in every eight or ten minutes.

"A chamber acid plant of ordinary design would be wholly inadequate to meet such variable conditions. The flue dust calls for special consideration since it carries a large percentage of zinc in the form of impalpable sulphates and oxides, that are prone to be carried into the system, clogging the gas passages and flues and even the circulating acid pipes. Moreover, zinc in itself is an important by-product to be recovered. It is in the special provisions, designed to meet these exceptional conditions, that this plant chiefly differs from the ordinary chamber plant.

"The course of the gases may be traced on the accompanying outline plan and elevation. The original smelting plant, before the manufacture of sulphuric acid was commenced, consisted of two furnaces of the usual water-jacketed type, each with an independent brick flue leading to a common brick dust chamber, at one end of which stands the old smoke stack, now cut off by a damper. From the furnace-dust chamber the gases now pass into and rise through a cylindrical tower, thence through a kite-shaped flue to the special dust catcher on a somewhat higher level. This dust catcher, with its connecting and extension flues, claims particular attention, as these control and regulate the temperature of the gases delivered to the Glover towers, as well as eliminate the zinc and other light dusts. The dust catcher proper consists of a rectangular brick chamber containing a system of channel irons. Each channel is held in place by trunnions resting in the walls. On one side the trunnions extend through the side wall, the ends being squared to take a wrench, by which means they can be revolved and their accumulated contents periodically dumped to the floor and later withdrawn through appropriate openings underneath. The coarser particles of flue dust readily come to rest in the anterior flues and furnace-dust chamber. The impalpable metallic oxides and sulphates respond but slowly to gravity at high temperatures, even at the slow speed attained in the flues and dust chamber, hence the introduction of the channel irons offering surfaces of repose at all points between the floor and roof of the dust catcher.



PLAN AND ELEVATION OF THE ACID PLANT.

"The control and regulation of the temperature of the gases is accomplished by directing their flow through a greater or lesser distance of the kite-shaped iron flue leading into the dust catcher. Referring to the plan, A, B and C, the tower-like extensions of the dust catcher, afford entrances thereto, while a fourth point of entrance is seen at its posterior end. By a simple system of dampers the gases may be admitted at any or all these entrances, in any desired proportion. On high temperatures, caused by exceptional conditions of the furnace, the gases are cooled by passing them through the whole course of the kite-shaped flue. On lower temperatures the whole or part may be admitted at any earlier point or points.

"From the dust catcher a brick flue runs the full length of the tower building with separate off-takes to each Glover tower. In each of these off-takes are placed niter boxes for the decomposition of the sodium nitrate. There is also an auxiliary set of similar niter boxes at the end of the dust catcher for use in emergencies. In addition to these, a special and original method of dealing with the valuable nitrous compounds has been worked out and put into successful operation.

"The gases having been cleansed of dust and brought to the proper degree of temperature are now ready for the first step of the process, viz., the two Glover towers, each 12 feet square and 45 feet high, filled with checkered layers of a patent chemical brick. Entering at the bottom of these towers, the gases ascend to the top, whence they are led downward again through a system of external pipes to enter the bottom of a special tower through which they again ascend and pass on their way to the chambers through two lead flues, each 42 inches in diameter. Special mention should be made of the extremely high oxidation of the SO_2. In these towers fully 40 per cent. of this gas is converted into SO_3. The concentration of the chamber acid is accomplished without any external aid from cast-iron pans, etc., generally used in the ordinary chamber process. While this plant has a normal rated capacity of 160 tons 60 degrees B. acid per day, it has been demonstrated that this quantity does not represent the maximum tonnage that can be produced, and furthermore a concentrating capacity of over 200 tons 60 degrees B. acid per day has been attained when needed.

"Situated between the towers and the chambers are four powerful fans to force the gases through the system. These consist of similar units, two forcing the gases into the front chambers, and two withdrawing them from the rear. These fans are made of hard lead (10 per cent. antimony and 90 per cent. lead) and are of special design. Next in train are the sixteen chambers, comprising two sets of eight each. Each chamber is 96 feet long, 22 feet 8 inches wide, and 30 feet high. The total volume of the chambers is 1,050,000 cubic feet. It is at this point in the process that the contaminating influence of the carbon dioxide is felt, and where special and novel features, of a proprietary nature, are successfully introduced to overcome its pernicious effects.

"From the chambers the gases pass into the six Gay Lussac towers, where the nitrogen compounds are recovered in the same manner as in all modern and well regulated chamber plants. It has been the belief of many acid manufacturers that only a 'sludge' acid could be produced in a chamber acid plant, utilizing the waste sulphur gases from a pyrite smelting furnace." This plant demonstrates the fallacy of the belief, the acid delivered from the towers to the storage tanks being pure and clear.

"Smelting operations have been reduced to a one-furnace basis to meet the capacity of the acid plant. This furnace smelts pyrrhotite ore six days in each week, the seventh day being devoted to the concentration of the low-grade matte produced during the ore-smelting period. The ore treated varies almost daily from 14 to 19 per cent. S, and averages about 16 per cent. S; the low-grade matte averages about 25 per cent. S. The problem of utilizing the gases from the matte concentration proved a simple one and considerably more acid is produced on this one day than on any of the ore-smelting days."

SCIENCE AND INDUSTRY.

A DISCUSSION OF THE PLACE OF SCIENTIFIC RESEARCH IN MODERN INDUSTRY.

Leo H. Baekeland—American Electrochemical Society.

IN the concluding article of his series on the compensation of workmen and efficiency of operation, presented in THE ENGINEERING MAGAZINE for June, Mr. H. L. Gantt emphasized the fact that while superb natural resources have enabled the United States to make phenomenal progress without much regard to the teachings of science and in many cases in spite of neglect of them, a point has now been reached where it must be recognized that the proper application of science to industry is of vital importance to the future prosperity of the country. At greater length Dr. Leo H. Baekeland discussed the same subject in his recent presidential address before the American Electrochemical Society, from which we abstract a few paragraphs dealing particularly with the place of scientific research in modern industry, after a report of his address in *Metallurgical and Chemical Engineering* for June.

"If this be the age of rational industrialism, of applied science, how is it that in some industries quality is going down while prices are soaring upward? It is a noteworthy fact that just such commodities as are produced by so-called scientific industries are sold cheaper and are of better quality than ever before, and this cheapening in price or bettering in quality is almost proportionate to the amount of scientific knowledge involved in their production. Let us take, for instance, the chemical and the electrical industries, both based nearly exclusively on well developed scientific data. In both these groups of industries the chemist or the physicist has had full sway and the engineer has embodied their work in a practical form. Free and rational competition based on intellectual superiority has been their paramount factor of development. Competition based on artificial privileges, like labor unions, tariff legislation, have paid only a secondary rôle.

"In some cases the changes are remarkable. For instance, a ton of sulphuric acid sells now at the same price as two pounds of the same article were sold about 150 years ago. Compare this with industries which are still under the sway of the rule of thumb, which means the rule of the ignorant, or where competition is based on political protection; you will find that just such rule-of-thumb commodities where science plays no role are those for which the public has to pay the highest price for the poorest article.

"Notwithstanding all our progress, it is evident that we live in a transitory stage; next to enterprises and industries embodying the highest intellectual conceptions our century can offer, we find even in the most advanced countries examples of conditions of affairs which seem truly an anachronism. To many of you it has happened to visit factories or mills where ignorance and greed seemed the two dominant factors, where the class of men and women employed, not to speak of child labor, seemed to have undergone the full curse of their sordid surroundings. Such places are to be found often where the mental condition of the directors does not enable them to go beyond the conception of size, and where the whole tendency has been toward more, more, more, instead of toward better, better, better. How different is this from some of our better engineering and chemical enterprises where everything bears the imprint of a steady effort toward progress and where employer and employed alike seem to undergo the uplifting force of intellectual aims. Such a happy condition of affairs is most likely to be encountered where the head is himself the scientific pioneer who has built up the enterprise.

"Matters are not always so satisfactory where large organizations have gotten into the hands of a board of directors who know little else of the technical side of the business than that it pays dividends, and for whom the main interesting factor is the value of the shares they own. Whenever undertakings are ruled by such a class of men, we must not be astonished if their corporation counsel is more in evidence than their chemists or their engineers. What do they care if certain improvements in their processes might net them 5 per cent. more or mean better goods, if on the other hand they know that by a clever trick of law they can extract from the consuming public many times more? No wonder, then, if they have less time and less mental fitness for a principle of science or engineering involved in a new process than for a conference with eminent law counsel. If they cannot alter nature's atomic weights, they may find a way of improving their invoice weights for the custom house. Again, we find that, resourceful as the modern engineer or chemist is, his power is often simply a tool in the hands of ignorant but cunning men. In fact, our modern laws and society insure better reward for cunningness or slyness than for true intellectuality.

"Quite frequently the real field of usefulness of scientifically trained men is much misunderstood. For instance, it is a common mistake, made even by some engineers and physicists, as well as by business men, to imagine that the main work of the chemist is confined to performing chemical analyses. This conception is about as absurd as to think that the usefulness of an electrical engineer consists in making electrical tests or that the essential work of the merchant is bookkeeping.

"Some of the better educated people in this country begin to understand more and more the necessity of scientific research. Not so long ago, research work was only carried out in the laboratories of universities or in a few highly developed chemical or electrical companies; nowadays we find many intelligently conducted enterprises devoting a considerable annual outlay for systematic research work, where the resources of the chemist, the physicist, and the biologist are used to good purpose. Unfortunately, the scope and method of scientific research is difficult to understand for the uninitiated. Some people have only the haziest conceptions on this subject. Some manufacturers, totally unaware of the requirements involved in this work, in a half skeptical way, grudgingly conclude to organize a research department, sometimes as a last resort, to help them through some difficulties; others do it 'to be in style,' and simply to imitate their more successful competitors. Frequently they engage a young man with little experience, who, outside of what he studied in the technical school or at the university, has everything to learn, and who besides that, is usually entrusted at the very start with the most difficult problems. His salary is none too high and his action is very much restricted; sometimes he is forbidden to study the current practical methods, or so-called 'manufacturing secrets,' and is thus prevented from getting acquainted with the very problems he is supposed to solve. I have seen other cases where the time of the research chemist was filled with odd jobs of every kind. After a while, when practical results are not forthcoming fast enough, the bookkeeper confronts him with the list of expenses which have been incurred by his work; naturally some comments are ready at hand how the same money spent on a good salesman would have shown immediate results, and so forth. Things go along that way for a while until the research department is abolished with the recurring remark: 'Research does not pay; we've tried it.'

"In other cases, where some results are obtained, the matter is taken out of the hands of the chemist before he has had time to fairly try and develop it on a large scale. The subject is now entrusted to the superintendent or the foreman, who seldom is a friend of the scientifically trained man, and nearly always resents anything which might diminish the prestige of established practical experience. Like in all new processes, defects are soon shown, and in the natural order of things repeated failures and renewed trials on a practical scale are required before there is any possibility of regular utilization. The research chemist is allowed very little intervention at this stage of the work, and after some time, remarks are heard how imperfect the whole thing was 'before so-and-so, the practical man, had his say.' Finally, initial expenses are charged against the research department, while the profits are credited to the practical man.

"A research department is a very difficult thing to organize and to run. It is not enough to provide a building and the necessary appliances; it is not enough to provide typewriters, card-indexing systems, and office force, and all the red tape connected with it; it is not sufficient to engage one or more well-behaved university or college graduates with the necessary helpers and to let them work under an orderly, businesslike manager. The most important, the almost exclusive factor in a successful research laboratory is the research chemist himself. If he is not a man who has a soul alive with his subject, if he is not enthusiastically imbued with his opportunities, if he is not qualified for his task, not only by scientific training, but specially by a natural gift of discrimination between what is most important in a problem and what is secondary to it, you might as well fill a hall with the marble statues of Greek poets and imagine that they will write poetry for you. Even if you have the best qualified research chemists, do not expect immediate results. Do not forget that problems, appearing most simple, require considerable time before they are thoroughly studied. Even in successful cases, it may easily require many years before a subject is so thoroughly elucidated that it can be taken up in practice.

"Let me give also a warning to such manufacturers as try to secure only by uncompromising secrecy the money-making end of their industries. As far as my experience goes, exaggerated secrecy is very often an indication of lack of knowledge of industrial feebleness and incompetency; a miser is most of the time a man of small means. If the chemists had been holding their results from each other, we would still be in the dark ages of the alchemist. No secrecy, however jealously carried out, can outweigh enlightened research work, protected by wise patent legislation. If our patent laws do not protect enough, then our prime duty becomes to change them until they answer their purpose as defined by the Constitution of the United States. The care with which patent laws are administered is a direct measure of the industrial importance of a country. Piracy cannot flourish, neither on the seas nor in intellectual property, if ethics of justice and equity can be made to prevail. Every recorded success of the scientist or the engineer is an additional evidence that ignorant greed and brutal rapacity cannot forever have full sway in this world, and that the rule of the sly and the shy leads to the abortion of progress."

ELECTRIC SPOT WELDING.

A BRIEF REVIEW OF THE METHODS, APPARATUS AND APPLICATIONS OF THE SPOT WELDING PROCESS.

A. E. Buckenberg—Electrical World.

SPOT welding, the latest development in electric welding processes, which is coming into extensive use for a great variety of work, has only one feature in common with ordinary butt welding, the formation of molecular union between semi-fluid metals by means of mechanical pressure. In general, electric butt welding is applicable to joining the ends of bars, rods, forgings, etc. The heating current is approximately evenly distributed over the entire area of the abutting surfaces; when a welding temperature is reached the two pieces are forced together endwise. Spot welding, on the other hand, is limited to the welding of overlapped sheets with comparatively large areas of metal in contact Only a small percentage of the actual contact area is joined, the welding area being confined to one or more distinct "spots." The heating current does not flow across the entire area of the contact surface, but is localized at the spots, while the remainder of the stock remains cold.

In *Electrical World* for June 2, A. E. Buchenberg outlines the means by which concentration of the heating current may be accomplished. Two methods are employed. "The first, commonly known as 'point welding,' necessitates the raising of slight independent points or projections on either one or both of the surfaces to be spot welded. These points prevent the entire overlapped surfaces of the stock from coming together, and the contact between them is, of course, made on the projecting points. If current is now caused to flow across the two pieces of work by means of flat current-carrying dies or electrodes (one on each side), the current between them must obviously be concentrated at the contracting points or projections of the metal. These projections under the heating action of the current almost instantly reach a fusing temperature, and the weld is completed by mechanical pressure exerted upon the dies to force the flat surfaces of the stock together. The points or projections on the metal may be of any size or shape to obtain the proper conditions of assembling or mechanical strength for any particular piece of work. One or more spots may be welded at the same instant with one operation. The principal objection to this method is the necessity of preparing the stock under a punch or press for the welding operation, and the difficulty of assembling some classes of work with projections on the surface of the stock.

"With the second method no preparation of the stock is required. The heating current is concentrated to the area of the spot to be welded by means of pointed dies or electrodes, one on each side of the work, whose opposed ends are shaped to the size of the spot weld required for any particular piece of work. The weld is completed as in the first method by means of mechanical pressure to force the dies together."

The essential parts of a spot-welding equipment for either of these methods are four: (1) a transformer to reduce the line voltage to the very low voltage required for welding; the current used is single-phase alternating; (2) two welding dies, one attached to either terminal of the transformer secondary winding, consisting of flat copper plates for the first method and short copper rods with rounded ends for the second method; the die-supporting mechanism is arranged to allow a limited motion of the dies toward and away from each other; (3) a powerful cam or toggle compression machine operating through the die supports, to exert mechanical pressure on the material between the dies; and (4) a switch to open and close the circuit through the primary coils of the transformer.

"The operation of the machine is as follows: The two parts to be spot welded are properly located by means of a jig between the opposed ends of the welding dies, which are normally separated to afford the proper clearance. The dies are now brought together by means of the compression handle to grip the stock between them. At this stage only enough pressure is exerted to bring the welding surfaces into contact. The switch is now closed and the stock begins to heat at the one spot directly between the opposed faces of the dies. When a welding temperature has been reached, the switch is opened and heavy pressure exerted by the compression lever to form the weld. The time required to make a spot weld is short, ranging from a fraction of one second on thin stock to three or four seconds on 0.25-inch stock. The time during which the current is used is so short that only a very small amount of heat is carried to the surrounding metal by conduction. On the thinner stock the discoloration from heat is barely noticeable beyond the area covered by the welding dies, while with heavier stock the discoloration may extend to a distance of 0.125 inch all around the weld.

"The diameter of the spot welds will depend upon the size of the projections thrown up on the surface of the metal or upon the area of the welding die contact points, which in either case may be of any desired area. Since the ultimate strength of the weld will in most cases be determined by the tearing strength of the metal around the circumference of the 'spot,' the diameter need not be great. A diameter of 0.25 inch is amply large for No. 20 gage stock and 0.375 inch for 0.25-inch stock. The number of welds required for any particular piece of work will depend upon manufacturing conditions and strength requirements." The momentary current required to make a spot weld is considerable, but the time is very short. Expert labor is not required. The actual energy consumption of the machine is surprisingly small and the cost of operation low.

When the stock has been previously prepared by punching up projections, as in the first method mentioned, flat welding dies of considerable area may be used. The heated plastic metal of the projection is brought back practically flush with the surfaces of the sheets under the pressure, and a smooth surface is left. In the case of comparatively heavy metal the depression left by the punch will be more prominent. The heat discoloration, as noted above, will, of course, always be present.

"Spot welds made without preparation of the stock by the use of pointed or rounded dies will usually show a slight depression below the surface of the plate on both sides of the work. These depressions will conform to the shape of the ends of the dies and are caused by the pressure exerted while the stock is hot. They are always slight, being hardly noticeable on thin stock and reaching a maximum depth of 0.03 inch on 0.25-inch stock. The usual heat discoloration is present in this method, as with the first. If it is desired to obtain a perfectly smooth, unbroken surface on one side of the stock and avoid the inconvenience and expense of preparing the stock as in the first method, the pointed dies on this side of the work may be replaced by a flat die or plate of copper.

"It is not necessary that the thickness of the two pieces to be spot welded be the same. Dissimilar metals, such as iron and brass, can be spot welded to each other in a very satisfactory manner. Spot welding, on account of its low cost and superiority over riveting in strength and the elimination of projecting rivet heads, is being applied to a wide variety of work, among which may be mentioned metal utensils, hardware specialties, metal furniture, automobile bodies, metal door and window casings, etc."

THE APPLICATION OF THE STEAM TURBINE TO LOCOMOTIVES.

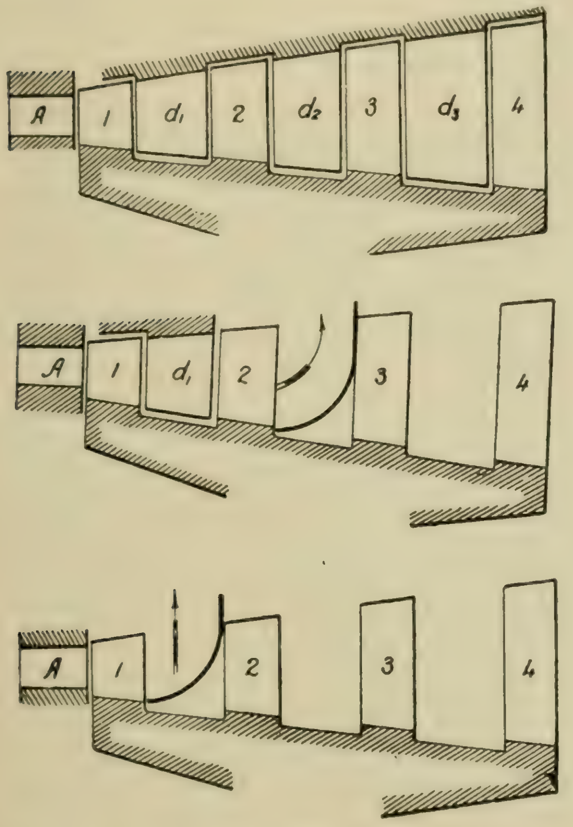
A BRIEF ACCOUNT OF THE REQUIREMENTS, A SPECIAL LOCOMOTIVE TURBINE, AND THE RESULTS OF SERVICE TESTS.

G. Belluzzo—Collegio degli Ingegneri ed Architetti in Milano.

THE possibility of applying the steam turbine to locomotives is under investigation on a considerable scale by a firm of engineers in Milan, Italy. A turbine of special design has been applied to an old locomotive and extended service trials have been carried out under exacting conditions. A few data of the results were made public in a paper read by G. Belluzzo in March before the Milan Association of Engineers and Architects, which is abstracted below, after reports in *L'Industria* for April 10, and *Revue Industrielle* for April 23.

Sig. Belluzzo first discussed the application of the steam turbine to marine service. A definitive and wholly satisfactory type of marine turbine, he says, has not yet been developed. The principal requirements are two, reversibility and a fair economy at variable speed, the latter particularly in war vessels. Reversing is accomplished by means of a special turbine, mounted on the same shaft as the main ahead turbine, but operating in the opposite direction, which turns in the condenser vacuum while the ship is going ahead. Its power is never more than one-half that of the main turbine. The problem of securing a reasonable economy at variable speed has not yet been satisfactorily solved; steam consumption per horse-power hour at mean speed is about 1.75 times that at full speed. It is important to remember that in marine applications of the turbine, there is an intimate relation between the speed and the power developed by the propulsive machinery; the power required at half speed is only one-eighth of that necessary at full speed.

On account of the nature of the service required of locomotives and the variations in the profile of the line, it is impossible to lay down any fixed rule connecting the power required and the speed. A locomotive may be called upon to develop its maximum power at various speeds, or various powers at a certain fixed speed. Further, the power must be the same whether the locomotive is running backward or forward and the machine must start under load. On the other hand, the space available for the driving machinery is very limited. A high efficiency is required under certain special conditions, as, for example, at full power and full and one-half speeds, inasmuch as the variation of steam consumption with power and speed in actual practice is of the order of 40 per cent.



FIGS. 1, 2, AND 3. SECTION OF TURBINE.

With the steam turbine, variable speed and high efficiency can be obtained by means of the arrangement illustrated in Figures 1 to 3. In the diagrams, *A* is a distributor in which the steam is expanded from the pressure at which it reaches the turbine to the pressure within the turbine casing. *1*, *2*, *3*, and *4* are sets of moving blades. At low speed the steam operates on all the blades in series (Figure 1), being directed by intermediate guides, d_1, d_2, d_3. At high speed it operates only on the first set (Figure 3), and at intermediate speeds, on two or three sets (Figure 2). The variations in efficiency and steam consumption are those which would obtain with a reciprocating engine at variable speed and load.

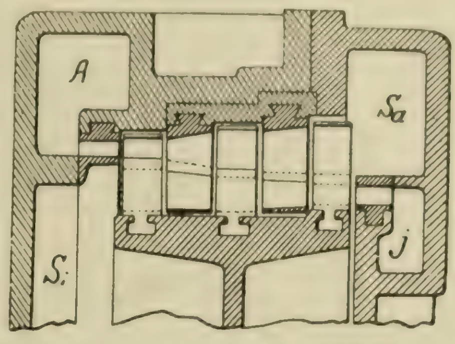


FIG. 4. REVERSING DEVICE.

Reversing is accomplished by means of the arrangement illustrated in Figure 4. The rotors carry two sets of blades, which are of opposite curvature. For operation in one direction, the steam is admitted at *A* and escapes at S_a; for reverse operation, admission is at *j* and escape at S_i. In either case the loss of energy due to the fan-like action of the second set of blades is a very small fraction of the total; numerous experiments made under various conditions of pressure and density of the steam have shown that the loss is only from 2 to 3 per cent. Starting under load is possible only with a turbine of the present type, by allowing the steam to operate on all the sets of blades at once. By this means the maximum turning moment is obtained with the least expenditure of steam.

A turbine of this type has been given a practical test by Miani Silvestri, Comi and Grondona, a firm of engineers in Milan. The turbine was applied to an old locomotive built in 1876, which was entirely reconstructed for the purpose. The boiler had about 650 square feet of heating surface and produced steam at about 142 pounds per square inch. The locomotive had originally three driving axles, but in the reconstructed machine the total weight, about 26 tons, is carried on two axles, between which the power of the motor, about 100 horse power, is divided.

The tests have been made on a very rough stretch of track. Accurate records of the variation of steam consumption with load and speed have been obtained. The steam consumption has never exceeded 35 pounds per horsepower hour in running in either direction. It is certain that a locomotive of double the weight and 6 to 10 times the power would give considerably lower results, with a boiler pressure 50 per cent. higher. The locomotive has started well under load, both on straight track and on curves, the turning moment being somewhat less than 3,500 foot-pounds.

The experiments have demonstrated that the advantages to be obtained by the application of the steam turbine to locomotives are the following: (1) possibility of higher speed; (2) suppression of oscillations; (3) a saving in lubricants; (4) a distinctly higher fuel economy; (5) longer life and lower maintenance costs; (6) greater ease of operation; and (7) elimination of danger in reversing.

SPECIAL AND STOCK HYDRAULIC TURBINES.

A COMPARISON OF THE CHARACTERISTIC FEATURES OF BUILT-TO-ORDER AND STOCK REACTION TURBINES.

H. Birchard Taylor—Engineering News.

IN his review of the development of the hydraulic reaction turbine in America, contributed to THE ENGINEERING MAGAZINE for March last, H. Birchard Taylor called attention to a fundamental difference between American and European practice in the early years of reaction-turbine design. In America reliance was placed almost wholly on empirical data, and hydraulic turbines were designed largely by the "cut-and-try" method. In Europe, on the other hand, the development of the reaction turbine was the outcome of mathematical investigation and its evolution was based largely on theory. This difference in method of design led to a difference in method of production. The typical American turbine was made from stock patterns in stock sizes; European turbines were almost universally built to order and it was customary to design each machine for the actual conditions of power, head and speed governing its installation. Within recent years, however, American designers have adopted European methods with, as Mr. Taylor shows very clearly, remarkably successful results, while the stock turbine has been introduced to some extent in Europe. Practice on both sides of the Atlantic now approximates to uniformity in methods of turbine production.

Progress in the production of theoretically correct built-to-order turbines has by no means displaced the stock turbine from the American market. There is a growing demand for the stock turbine and the manufacture of this grade of machinery has developed into a large and profitable industry. Mr. Taylor has indicated, in an article contributed to *Engineering News* for May 26, the characteristic features of special and stock hydraulic turbines and the fields to which they are respectively adapted. It is rare, he says, to find both classes of apparatus manufactured by the same concern. The grade of workmanship is much higher in the special turbine, and the makers of hydraulic machinery find it impracticable to turn out two grades of workmanship in the same shop. Hence the manufacture of special and stock turbines embraces two specialized industries.

The built-to-order turbine, as a rule, has a far higher efficiency, both hydraulic and mechanical, than a stock turbine which would apply to the same conditions. Stock turbines are made in lots from standard patterns. They are distinctly a product of the testing flume, and while very high efficiencies have been recorded in flume tests of stock runners, such results cannot be depended upon as a reliable indication of the economy of the completed unit. In general, stock runners are applied to inefficient wheel casings and draft tubes, and, consequently, the efficiency of stock turbines as a class is low. Under the conditions for which they are intended, however, stock turbines have given entire satisfaction. They find their application in cases where low first cost and quick delivery are the principal requisites, and where efficiency, cost of maintenance, regularity of operation and appearance are secondary considerations. The fact that first cost is the controlling factor in the purchase of equipment in the majority of small installations will insure a steady increase in the demand for the stock turbine.

The difference in cost between special and stock turbines is easily explained. The drawings and patterns for a made-to-order turbine are seldom, if ever, used a second time, except for duplicate machines for the same power house. Two installations rarely require wheels for exactly the same combination of the variables on which the design of a turbine depends. The development charges constitute a large part of the cost of hydraulic machinery, and in the case of the made-to-order turbine these must be charged to the cost of the unit. The manufacturer of stock turbines, on the other hand, can in most cases supply a standard machine which can be adapted to fulfill the conditions. Even if he has to make a new set of patterns, their cost is not charged to the individual unit but to plant, since the patterns can be used for the construction of many turbines for installations offering approximately the same conditions.

"The principal field of application for the stock turbine is for heads under 100 feet and for capacities not exceeding 2,000 horse power. Owing to the absence of development charges and the resulting low first cost of this class of apparatus, the stock turbine has a great advantage within this range, and the market for made-to-order turbines, within these limits of head and power, is confined to cases where the question of efficiency is of prime importance, or where unusually high factors of safety are required in the construction, owing to peculiar local conditions.

"The made-to-order turbine finds its application in installations where one or more of the following requirements are of principal importance: (1) high efficiency; (2) non-erosion of the runner vanes, a requirement which becomes more important the higher the head; (3) high factors of safety in the construction of the apparatus; (4) low operating expense; (5) unusual design called for by peculiar local conditions; (6) capacity considerably above the range to which the stock turbine may be applied; (7) heads much over 100 feet. In all of these cases the question of first cost must necessarily be of secondary importance.

"In installations where special turbines are required and where efficiency is the most importance of all considerations, it has been customary in recent years for the purchaser to require the manufacturer to guarantee the efficiency of the apparatus on a bonus-and-penalty basis, the rate depending on the value to the purchaser of that increase in the power output which is obtained by a gain of 1 per cent. in the efficiency. A common rate has been $1,000 for each per cent. per turbine. If the contractor exceeds his guarantee by 1 per cent. it does not necessarily follow that he has made $1,000. Especially is this true when the value guaranteed is about the highest efficiency which would be expected for the conditions of power, head and speed, and the contractor in an effort to exceed his guarantee goes to considerable expense in the construction and testing of experimental runners" and in the construction of the turbine of more liberal proportions than he counted on when he signed the contract. The extra expense is justified, however, provided the experiments and the enlargement of the turbine do not increase the cost by more than the amount of the bonus.

Stock turbines as a class have experienced much trouble from erosion of the wheel vanes, especially when they have been applied to the higher heads. "Erosion depends primarily upon the design. To eliminate it, among other things, the hydraulic design must be very close to the correct, and the allowable variation from the correct is less the higher the head. As has been pointed out, in a majority of the applications of the stock turbine the conditions of power, head and speed are somewhat different from those for which the wheel was originally intended; consequently the design cannot be said to be very near the correct. The natural result, in a great number of cases, is the rapid erosion of the wheel vanes, a condition which not only reduces the efficiency of the turbines at an accelerated rate, but soon destroys the vanes to such an extent that the runner or runners must be replaced. Thus the maintenance of the turbine becomes an important item.

"Turbines which are fed by long penstocks are more or less subject to fluctuations of pressure in the wheel casing. In such cases it is extremely important to have the turbines designed especially to withstand the resulting variation in the stresses in the wheel casing and head plates. The magnitude of the pressure change depends, among other things, upon the length of the penstock and upon the rate of the change of the velocity of the water in the penstock. The rate of change of velocity depends upon the velocity of the wheel gates as they are moved by the governor to suit the variations in the load."

When the gates of a turbine close to suit a drop in the load, the force required to decrease the velocity of the water flowing in the penstock is evidenced by a rise in the pressure in the wheel casing. Conversely, when the gates are opened to suit an increase in load, the force required to increase the velocity of the water is evidenced by a fall in the pressure in the wheel casing. The question of the pressure variations to which a turbine may be subjected deserves the most thorough study before the various parts are proportioned and the thickness of metal chosen.

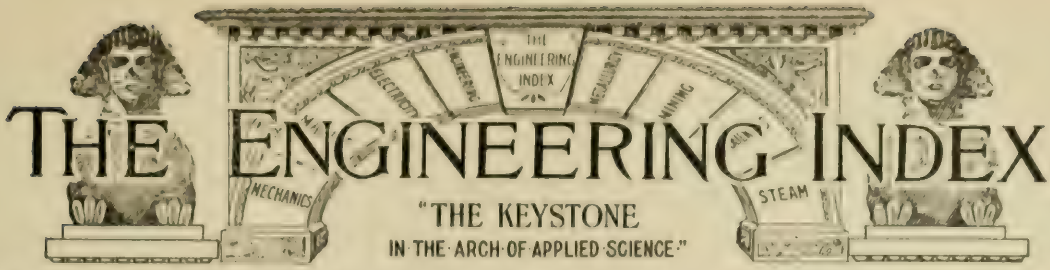
"The elementary action involved in these pressure fluctuations is not very complex. But in actual practice there are many influences which modify the phenomenon to a greater or less degree, and consequently it is practically impossible to derive a formula which would take into consideration all the phases of the subject. Approximate results, however, may be calculated which should be of value to the designer." Assuming that the penstock is frictionless and inelastic, that the discharge is proportional to the gate opening, and that we are dealing with an incompressible fluid, results close enough for all practical purposes are obtained from the formula.

$$p = 0.0134\, L\, \frac{v_1 - v_2}{t}$$

in which p is the pressure change in pounds per square inch, L, the length of the penstock in feet, v_1 and v_2, the initial and final velocities of the water, and t, the time in seconds required to change the velocity from v_1 to v_2 or from v_2 *to* v_1.

"The rise or fall in the pressure is directly proportional to the length of the penstock, directly proportional to the difference in velocities corresponding to the two loads on the turbine, and inversely proportional to the time required to move the wheel gates. It is easily seen that, for loads coming on the turbine, if the time for the movement of the gates is not adjusted to the inclinations of and the velocities through the various sections of the penstock, the fall in pressure may be such as to reduce the pressure in a section of the penstock below the atmospheric pressure and cause its collapse.

"In actual practice the pressure fluctuations are considerably reduced by means of surge tanks, standpipes and relief valves. Still, in cases where very long penstocks are required and where rapid movements of the wheel gates are necessary to secure good regulation, the designers should appreciate the importance of going into this question thoroughly and of making liberal allowances in choosing the factors of safety in the construction of the turbine."



THE ENGINEERING INDEX

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Divisions of The Engineering Index.

Civil Engineering............... Page 607
Electrical Engineering......... " 615
Industrial Economy............ " 621
Marine and Naval Engineering " 622
Mechanical Engineering........ Page 624
Mining and Metallurgy........ " 630
Railway Engineering........... " 643
Street and Electric Railways.. " 646

CIVIL ENGINEERING.

BRIDGES.

Arches.

Determination of Wind Stresses in Three-Hinged Arches. J. Ensink. Gives methods and diagrams recently worked out by the author in connection with an arch span carrying a water main. 2500 w. Eng Rec—May 21, 1910. No. 14148.

The Analytic Calculation of a Concrete Arch. Malverd A. Howe. Detailed discussion of the necessary steps in designing an arch rib or ring of reinforced concrete, according to the elastic theory and the unit load method. 3000 w. Eng News—May 12, 1910. No. 13891.

Floors.

See Waterproofing, under Construction.

Frankfort, Germany.

Frankfort's Bridges. Illustrates and describes interesting structures. 1200 w. Pub Works—Jan., 1910. No. 14175 A.

Piers.

The Copper River Bridge Piers. Illustrated description of piers constructed where the substructure must resist pressure and impact from large flows of thick ice and from very heavy icebergs formed by glaciers. 600 w. Eng Rec—May 14, 1910. No. 13906.

Quebec.

An 1800-Ft. Steel Arch as a Quebec Bridge Project. Drawings and general description of a design for a voussoir arch to cross the St. Lawrence River at the site of the collapsed Quebec Bridge. 1200 w. Eng News—May 19, 1910. No. 14121.

Reconstruction.

Boylston Street Bridge Renewal Erection. Illustrated detailed description of a bridge across railway tracks in Boston. 2500 w. Eng Rec—May 7, 1910. No. 13798.

Reinforced Concrete.

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Reinforced-Concrete Highway Bridges (Strassenbrücken in Eisenbeton). Emil Morgenstern. Describes three recent structures in Germany. Ills. 2000 w. Beton u Eisen—April 5, 1910. No. 14213 F.

See also Arches, under Bridges.

Steel.

Decay and Protection of Railway Bridges. Illustrated notes on recent Scottish practice. Concrete is used for protection of the steel. 1000 w. Engr, Lond—May 6, 1910. No. 13982 A.

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Suspension.

The Gisclard Type of Fixed Suspension Bridge (Les Ponts suspendus Fixes, Système Gisclard). G. Leinckugel Le Cocq. Discusses particularly the Cassagne bridge in the Pyrenees. Ills. 5000 w. Génie Civil—April 9, 1910. No. 14027 D.

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Concrete.

Subaqueous Concrete Work. H. R. Lordly. Describes operations of this character in connection with the Quebec canal system, particularly the construction of five miles of concrete wall without unwatering on the Lachine Canal. Ills. 7000 w. Can Soc of Civ Engrs—March 17, 1910. No. 14200 N.

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The Determination of Earth Pressures (Neue Versuche zur Bestimmung des Erddrucks). Prof. Ramisch. An exhaustive mathematical discussion. Ills. 5500 w. Zeitschr d Oest Ing u Arch Ver—April 15, 1910. No. 14204 D.

See also Retaining Walls, under CONSTRUCTION.

Excavation.

A Four-Wheeled Scraper of Large Capacity for Excavation and Grading. Illustrated description of a machine with a scraper of 1 cu. yd. capacity. 1000 w. Eng News—May 19, 1910. No. 14126.

Fireproof.

Fires: Effects on Building Material and Permanent Elimination. Frank B. Gilbreth. Urges the elimination of wood from all building construction. Ills. 4000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14331 F.

Floors.

Cost of the Concrete Balcony Floors of the Lockport Power House, Chicago Drainage Canal. L. K. Sherman. Describes the construction of these reinforced-concrete floors, giving estimate of cost. The work was done by day labor. Ills. 1600 w. Engng-Con—May 25, 1910. No. 14394.

Concrete Floors with Crossed Reinforcement (Kreuzweise bewehrte Eisenbetondecken). H. Henningsen. Mathematical discussion of their design. Ills. 2000 w. Beton u Eisen—April 5, 1910. No. 14214 F.

Foundations.

A Method of Sinking Curbed Foundation Wells Using Shields and Compressed Air with Some Notes on Chicago "Caisson" Foundations. From a paper by W. C. Armstrong in the *Iowa Engr.* Explains conditions at Chicago and the methods used to give safe foundations for heavy structures. 3500 w. Engng-Con—May 11, 1910. No. 13913.

The Bryant Building Substructure. Describes methods of removing the old 9-story building on the site, and the interesting details of the caisson foundations, etc. Ills. 3000 w. Eng Rec—May 21, 1910. No. 14151.

The London County Hall. Information and drawings concerning the site and foundations, with description. 1800 w. Engr, Lond—April 29, 1910. No. 13860 A.

Gas Holders.

The Reconstruction of the Concrete Tank in Connection with the 150,000 Cubic Foot Gasholder, the Property of "The Light, Heat, and Power Department," City of Kingston, Ontario. C. C. Folger. Explains the system adopted and the results accomplished. Ills. 1500 w. Am Gas Lgt Jour—May 23, 1910. No. 14158.

Piling.

Concrete Piles. Fred J. Biele. Abstract of a thesis giving a comparative description of different types. Ills. 3000 w. Cornell Civ Engr—May, 1910. No. 14309 C.

Cement and Concrete for Protecting Piles in Sea Water. Ralph Barker. Considers methods of protecting timber piling, and report of sea-water experiments to determine the best resistant cement, and the methods of application at San Francisco. 2500 w. Cement—April, 1910. No. 13791 C.

Pipe Conduits.

Standard Specifications for Underground Construction Adopted by the City of Seattle, Washington. H. L. Estep. Information concerning specifications for regulating the location, methods of work, and materials used. Ills. 2500 w. Eng News—May 12, 1910. No. 13892.

Regulations.

Regulations for Reinforced-Concrete Construction (Vorschriften für Eisenbetonbauten). Erich Vossnack. Discusses the new Swiss regulations and compares them with other codes. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14243 D.

Reinforced Concrete.

The Design of Reinforced-Concrete Beams (Eisenbeton-Kontrollbalken). E. Suenson. Draws from the results of a series of tests conclusions as to the proper relation between concrete and reinforcement. Ills. 3700 w. Beton u Eisen—April 23, 1910. No. 14217 F.

Graphical Determination of the Moment of Resistance of Reinforced-Concrete Slabs and Beams (Graphische Berechnung der Widerstandsmomente von Eisenbetonplatten und -Plattenbalken). Herr von Bronneck. Mathematical demonstration of method. Ills. 2000 w. Oest Wochenschr f d Oeffentlich Baudienst—April 16, 1910. No. 14210 D.

General Post Office. Thomas A. Watson. Read before the Jun. Inst. of Engrs. Describes new buildings of reinforced concrete. 4500 w. Pub Works—Feb., 1910. No. 14177 A.

A Twenty-Eight Class School Building in Essen-Ruhr (Neubau einer 28 klassigen Gemeindeschule für die Stadt Essen-Ruhr). Rudolf Giese. Illustrated description of an interesting concrete structure.

2000 w. Beton u Eisen—April 5, 1910. No. 14212 F.

Construction of a Cement Mill for the Ehrenhausen Portland Cement Company in Retznay (Bau einer Zementfabrik für die Ehrenhausener Portlandzementwerke in Retznay, Steiermark). Mario Genel. Describes an interesting concrete mill building. Ills. 2000 w. Beton u Eisen—April 23, 1910. No. 14215 F.

Reinforced-Concrete Mortuary Chapel in Rostock-Damerow (Eisenbetonkonstruktionen der Einsegnungshalle der Friedhofsneubauten in Rostock-Damerow). J. Gaugusch. Describes a structure with an arched roof. Mathematical. Ills. 3600 w. Beton u Eisen—April 23, 1910. No. 14216 F.

See also Regulations, and Stacks, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Water Works, under WATER SUPPLY; and Docks, under WATERWAYS AND HARBORS.

Retaining Walls.

The Theory of Earth Pressure on Retaining Walls (Zur Theorie des Erddruckes auf Stützmauern). Max Ritter. Mathematical. Ills. 2700 w. Schweiz Bau—April 9, 1910. No. 14086 B.

See also Concrete, under CONSTRUCTION.

Stacks.

Concrete Chimney Construction. Carl Weber. Illustrated account of the author's work, showing the adaptability of reinforced-concrete for chimney construction and its advantages over other types. The theory and design are also discussed. 6500 w. Cement—April, 1910. No. 13788 C.

Steel.

Framework of New 22d Regiment Armory, New York City; A Three-Hinged Arch Roof with Cantilever Skewback Supports. Illustrated description of a new application of 3-hinged arch roof framing. 1500 w. Eng News—May 5, 1910. No. 13776.

New Buildings of the Jones & Laughlin Number 14 Mill. Illustrated detailed description of interesting features of structural steel work. 2500 w. Eng Rec—May 14, 1910. No. 13905.

The New Balloon Shed at Aldershot. Drawings, illustrations, and description of army balloon sheds recently built in England. 1800 w. Engr, Lond—May 13, 1910. No. 14253 A.

Tunnels.

Completion of the Pennsylvania Railroad Tunnels and Terminal Station. Illustrations and information concerning this beautiful terminal building in New York City. 2000 w. Sci Am—May 14, 1910. No. 13886.

The Pennsylvania Railroad Terminal in New York. Illustrations and brief description of the New York tunnel extension and terminal building. 3500 w. Sci Am Sup—May 14, 1910. No. 13888.

New York Tunnel Extension of the Pennsylvania Railroad. The North River Tunnels. B. H. M. Hewett and W. L. Brown. Describes briefly the actual designs finally adopted, the actual conditions met, and the methods of construction adopted. Ills. 43000 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14341 E.

The New York Tunnel Extension of the Pennsylvania Railroad. Meadows Division and Harrison Transfer Yard. E. B. Temple. Illustrated detailed description of his portion of the work. 3000 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14338 E.

The Elbe Tunnel in Hamburg (Der Elbetunnel in Hamburg). A. Kroitzsch. Describes briefly the construction of two tunnels under the Elbe River. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—April 9, 1910. No. 14209 D.

Underpinning.

Underpinning a 300-Ton Column on Quicksand. Brief illustrated description of unusual reinforcement of foundations found necessary in New York City, and the methods used. 800 w. Eng Rec—May 14, 1910. No. 13909.

Waterproofing.

The Waterproofing of Extensive Railroad Bridge Floors. Illustrates and describes methods used for the extensive structures approaching the large terminal of the C. & N.-W. Ry. in Chicago. 1500 w. Eng Rec—May 14, 1910. No. 13908.

MATERIALS OF CONSTRUCTION.

Cement.

Action of Sea Water on Portland Cement. J. M. O'Hara. Gives results of investigations made by the writer on a number of brands of Portland cement subjected to the action of sea water. 1800 w. Eng Rec May 21, 1910. No. 14157.

Concrete.

The Preparation of Concrete; From a Selection of Materials to Final Deposition. Harry Franklin Porter. Discusses the materials, their treatment, the function of cement, etc. 1800 w. Cornell Civ Engr—May, 1910. No. 14310 C.

The Effects of Sewage and Sewage Gases on Portland Cement Concrete. Sidney H. Chambers. Abstract of an article read before the Concrete Inst., London. Describes briefly the conditions and the character of the sewage, and the investigations that seem to prove that under certain conditions the gases cause disintegration. 3500 w. Archt, Lond—April 29, 1910. No. 13837 A.

Paints.

Paint for Iron and Steel. Frank Neal. Gives results of practical experience. 1500

w. Jour Assn of Engng Soc's—April, 1910. No. 14324 C.

Reinforced Concrete.

Reinforced Concrete and Steel Frame Buildings. F. E. G. Badger. Discusses the value of concrete as a material for encasing steel frames, and of reinforced-concrete for construction. 1800 w. Cement—April, 1910. No. 13790 C.

Reinforced Concrete Columns. Peter Gillespie. A report of experimental work, and statement of inferences from evidence obtained. Ills. 3000 w. Ap Sci—April, 1910. No. 14283 C.

Spirally Armored Concrete. A letter from A. Considère, giving a critical review of an article by W. Noble Twelvetrees which discussed the tests made by Prof. Arthur N. Talbot. 3000 w. Engng—May 6, 1910. No. 13977 A.

Concrete with Spiral Reinforcement (Der umschnürte Beton). A discussion by M. Considère of the results of the tests by Prof. Talbot on spirally reinforced columns. Ills. 3500 w. Beton u Eisen—April 23, 1910. No. 14218 F.

Timber Preservation.

The New Timber Treating Plant of the Eppinger & Russell Co. at Jacksonville, Fla. Grant B. Shipley. Illustrated description of this new plant and the arrangements for handling ties, piling and lumber. 2500 w. Eng News—May 12, 1910. No. 13889.

MEASUREMENT.

Hydrographic Surveying.

The Determination of Ordinary High Water Plane on the Pacific Coast of the United States. A discussion by D. E. Hughes and Otto von Geldern. Ills. 12000 w. Jour Assn of Engng Soc's—April, 1910. No. 14320 C.

Surveying.

Primary Transverse Work of the Bronx Topographical Bureau, New York City. Describes methods and instruments used for accurate work. 1700 w. Eng News—May 19, 1910. No. 14125.

MUNICIPAL.

City Planning.

Second National Conference on City Planning and the Problems of Congestion. An outline of the proceedings at the meeting in Rochester, N. Y. 4000 w. Eng News—May 12, 1910. No. 13894.

Town Planning—A Review of the Position. Robert H. Haynes. Read before the Inc. Assn. of Munic. & Co. Engrs. Briefly considers various systems, discussing details. 5500 w. Surveyor—May 13, 1910. No. 14188 A.

The Planning of Undeveloped City Areas. Nelson P. Lewis. Read at the Conference in Rochester, N. Y. Discusses mainly the conditions of American cities. 2500 w. Eng News—May 12, 1910. No. 13895.

City Planning and Building Ordinances with Respect to Small Dwellings (Stadtbauplan und Bauordnung im Hinblicke auf Kleinwohnungen). Josef Hermann Stübben. Reviews the small-dwelling situation in various cities and countries and suggests a set of building regulations. 7000 w. Zeitschr d Oest Ing u Arch Ver—April 22, 1910. No. 14206 D.

The Relation of Buildings, Retaining Walls and Bridges, and Their Surroundings to City Development. John R. Rockart, J. D. Waterman, and C. W. Lord. A general discussion of imporvements in various cities. Ills. 4500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14358 N.

Drainage.

Preliminary Work in the Tallahatchie Drainage District. Data from a paper by A. L. Dabney, read before the Ill. Soc. of Engrs. & Surv. concerning a district in the alluvial valley of the Mississippi River. 2200 w. Eng Rec—April 30, 1910. No. 13629.

The Drainage of the Mantovano-Reggiano District (La Bonifica dell' Agro Mantovano-Reggiano). Describes an extensive drainage system in this part of Italy. Ills. 3200 w. Monit Tech—April 20, 1910. No. 14041 D.

Pavements.

Suggestions for a Rational Formula for Street Pavement Crowns. G. B. Zahniser. Gives various rules and formulae available, with comments and suggestions. 2000 w. Eng News—May 5, 1910. No. 13775.

The Use of Concrete in the Construction of Pavements. James Pearson. Read before the Can. Cement Assn. Shows the important part Portland Cement or concrete is taking in improving the quality of pavements. 2500 w. Can Engr—April 29, 1910. No. 13641.

Wood Paving. James P. Norrington. Presents an account of wood carried out and the duration of the pavements. 2000 w. Surveyor—April 22, 1910. No. 13720 A.

A Metallic Plug for Wood-Block Pavements (Un Tampon métallique pour le Pavage en Bois). M. P. Toulon. Describes a device used in Paris for preventing deformation of wood pavements through expansion of the blocks. Ills. 1200 w. Bul Soc d' Encour—March, 1910. No. 14008 G.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Illustrates and describes types of destructors. 2000 w. Munic Engng—May, 1910. No. 14272 C.

Refuse Disposal in Milwaukee. Fred S. Sly. An account of methods and plants used during the past thirty years, with illustrated description of present plant and its working. 5500 w. Munic Jour & Engr—May 4, 1910. No. 13756.

Roads.

Road Administration and Maintenance. Logan Waller Page. The subject is treated from the economic and administrative points of view. 3500 w. Jour Fr Inst—May, 1910. No. 14292 D.

Destructive Action of Motor Traffic on Road Surfaces and Methods of Construction to Prevent It. W. H. Fulweiler. Ills. Discussion. 9600 w. Pro Engrs' Club of Philadelphia—April, 1910. No. 14270 D.

The Road Question from the Users' Point of View. R. J. Mecredy. Read before the Irish Road Cong. Describes conditions in Ireland. 4000 w. Surveyor—May 13, 1910. No. 14189 A.

Trunk Roads. M. A. Ennis. Read before the Irish Road Congress. Considers their construction, maintenance and control. 2500 w. Surveyor—April 22, 1910. No. 13722 A.

Suitable System of Public Highways for the South. Archer B. Hulbert. Describes condition of the Southern roads and discusses the steps that should be taken for their improvement. 4500 w. Mfrs' Rec—May 19, 1910. No. 14102.

The Highway System of Los Angeles County, California. Burt A. Heinly. An illustrated account of the extensive improvements in progress, describing methods, and structures of interest. Ills. 3500 w. Munic Engng—May, 1910. No. 14273 C.

Economical Supply of Road Metal. John W. Leebody. Read before the Irish Road Congress. Gives an account of methods and results from direct ownership of a quarry. 2500 w. Surveyor—April 22, 1910. No. 13723 A.

Up-to-Date Roads. R. O. Wynne-Roberts. Refers only to macadamized roads under the classification of national, county, urban, and rural, considering each in detail. 4000 w. Soc of Engrs—May 2, 1910. No. 14187 N.

Sand-Clay Road Construction in Kansas and Some Data on Its Cost. W. S. Gearhart. Abstract of a paper read at the Missouri Highway Engrs. Assn. 2000 w. Engng-Con—May 18, 1910. No. 14118.

Road-Crust Construction. Jos. Mathison. An account of results obtained with a road surfaced with Ferromac. 3000 w. Surveyor—April 22, 1910. No. 13721 A.

The Use of Tar on Roads. A. D. Whittaker. Read before the So. Gas Assn. Describes work in the vicinity of Atlanta, Ga., and the preparation of materials, cost, etc. Ills. 7000 w. Pro Age—May 16, 1910. No. 13933.

Tar-Macadam: A Plea for Standardization. J. Walker Smith. Discusses the advantages and disadvantages of pitch macadam, and tar-concrete, and the tests applied, etc. 12000 w. Surveyor—April 22, 1910. No. 13719 A.

The Steam Rolling of Roads. E. A. Hackett. Read before the Irish Road Cong. Deals with advantages and effectiveness of steam rolling. 2000 w. Surveyor—May 13, 1910. Serial. 1st part. No. 14190 A.

Convex, Concave and Centre-Channel Roads. Harold G. Turner. Considers the pros and cons of each system. 2000 w. Surveyor—April 22, 1910. No. 13718 A.

See also Commercial Vehicles, under MECHANICAL ENGINEERING, AUTOMOBILES.

Sanitary Stations.

Public Sanitary Station at Brookline. Alexis H. French. Illustrated description of a structure of Portland cement concrete. 700 w. Jour Assn of Engng Soc's—April, 1910. No. 14321 C.

Public Sanitary Station at Lawrence. Arthur D. Marble. Illustrated description of a concrete structure. 2200 w. Jour Assn of Engng Soc's—April, 1910. No. 14322 C.

Sanitation.

The Ontario Board of Health Experimental Plant. F. H. Chesnut. Describes the plant and its work. Ills. 2500 w. Ap Sci—April, 1910. No. 14282 C.

The Holding Method of Milk Pasteurization. Charles E. North. An account of the evolution of this method of protecting the milk supply, with a brief description of the apparatus now used and the results obtained. Also editorial. 4500 w. Eng News—May 12, 1910. No. 13896.

Municipal Sanitation (La Réglementation de l'Habitation au Point de Vue de l'Hygiène). Maurice Bellom. An outline of the regulations governing the condemnation of unsanitary buildings in France, Belgium and England. 3300 w. Génie Civil—April 2, 1910. No. 14026 D.

Sewage Disposal.

The Royal Commission on Sewage Disposal. A review of Appendix IV to the Fifth Report of the Royal Commission on Sewage Disposal. 2500 w. Engr, Lond—April 22, 1910. Serial. 1st part. No. 13732 A.

Sewage Disposal Ideals. W. C. Easdale. Defines the ideals that should be aimed at in tanks, filters, distribution, etc. 3500 w. Can Engr—May 20, 1910. No. 14143.

Removal of Organic Matter from Sewage by Screens and Tanks. Emil Kuichling. Gives data relating to the efficiency of fine screens, showing the benefits, and that the cost is much less than that of sedimentation. 4000 w. Eng Rec—May 21, 1910. No. 14153.

Sewage Disposal Plant at Lancaster, New York. Plans and description of a plant for a city of 4000 population, comprising grit chambers, septic tanks and contact beds. 1000 w. Eng Rec—May 7, 1910. No. 13799.

Sewage Disposal Works at Indiana, Pennsylvania. Illustrated description of works executed in plain and reinforced-concrete for a town of about 8000 population. 2000 w. Eng Rec—April 30, 1910. No. 13628.

Leicester Sewage Works. E. George Mawley. Describes a system of purification by sedimentation tanks, single contact beds and broad irrigation on clay land. 4500 w. Surveyor—April 29, 1910. No. 13847 A.

Glasgow Sewage Disposal. Illustrated description of the Shieldhall sewage works and main drainage scheme. 3500 w. Engr, Lond—May 13, 1910. No. 14256 A.

The Glasgow Main-Drainage Works. Illustrated description of the extensive scheme for the purification of the sewage of the city, so that it may safely be passed into the River Clyde. 4800 w. Engng—April 29, 1910. Serial. 1st part. No. 13852 A.

See also Purification, under WATER SUPPLY.

Sewer Pipe.

Some Experiments on the Cost and Durability of Cement Drain Tile. W. H. Day. Read before the Can. Cement & Concrete Assn. Gives the cost of making cement tile by hand, and a report of solubility tests. 2500 w. Cement—April, 1910. No. 13789 C.

Sewers.

Methods of Constructing the Western Ave. Sewer, Chicago, Ill. Illustrated description of the methods employed in constructing a concrete sewer, without reinforcement. 1600 w. Engng-Con—May 4, 1910. No. 13757.

WATER SUPPLY.

Analysis.

Chemistry, and the Conservation of Our Water Resources. Prof. Marston Taylor Bogert. Shows the importance of purity of the water supply, and the services of the chemist in determining its quality. 1200 w. Jour Fr Inst—May, 1910. No. 14294 D.

Aqueducts.

The Progress of the Los Angeles Aqueduct. An illustrated account of this great engineering work, and the rapid progress made in its construction. 3500 w. Eng Rec—May 21, 1910. No. 14147.

The Los Angeles Aqueduct: Structural Details, Economic Studies, Working Organization, and Service Constructions. Outline of the development and character of this great engineering work and of its management. Ills. 5500 w. Engng-Con—May 4, 1910. No. 13758.

Dams.

Some Recent Considerations of Stresses in High Masonry Dams. Charles E. Morrison. Outlines the analysis given in a paper by L. W. Atcherley "On Some Disregarded Points in the Stability of Masonry Dams," calling attention to some of the discussion which followed, in order to indicate the status of the theory involved in the design of such structures. 7000 w. Sch of Mines Qr—Jan., 1910. No. 14301 D.

Discharge Coefficients.

Coefficients of Discharge for Flow Through a Notch in the McCall Ferry Dam. R. H. Anderson. Illustrates and describes experiments made to determine a coefficient of discharge to be applied in estimating the flow through similar openings. 1400 w. Cornell Civ Engr—May, 1910. No. 14307 C.

Filtration.

Water Filtration in Theory and Practice. George C. Whipple. Deals with the requirements of a water supply, methods of purification, theory of filtration, coagulation, aeration, disinfection, etc. Ills. 7500 w. Can Engr—May 6, 1910. No. 13816.

Toronto Filtration Plant. Francis F. Longley. Illustrated description of a plant for purifying lake water. 2200 w. Munic Jour & Engr—May 18, 1910. No. 14112.

Fort William.

Fort William Water Supply. H. Sydney Hancock, Jr. An illustrated account of an undertaking carried out under unfavorable conditions. Especially describes the difficulties encountered. 33500 w. Can Soc of Civ Engrs—1910. No. 14297 N.

Impurities.

Lead in Drinking Water. A discussion of the troubles in Great Britain from the moorland waters and lead piping. 2000 w. Engr, Lond—April 29, 1910. No. 13858 A.

Irrigation.

The Economy Resulting from the Use of the Level on the Farm. George M. Lewis. Suggestions for increasing the efficiency of water in irrigated districts. 1400 w. Jour Assn of Engng Soc's—April, 1910. No. 14323 C.

Field Location of Canals for Irrigation. L. R. Balch. Describes the preliminary and final location. 1500 w. Pub Works—Feb., 1910. No. 14178 A.

Method of Lining an Irrigation Canal With Cement Plaster, With a Discussion on Cement Plaster versus Lime and Cement Plaster. W. D'Rohan. Describes work on a canal of the Standley project, Colorado. 2000 w. Engng-Con—May 18, 1910. No. 14119.

London.

London Water Supply. A discussion of the future water supply and explanation of the "progressive scheme" adopted. 2500 w. Engr, Lond—April 29, 1910. No. 13862 A.

Panama Canal.

Hydraulics of the Chagres River. Gen. Henry L. Abbot. Shows that the water supply for the Panama Canal will be fully adequate for its operation. 3000 w. Engineering Magazine—June, 1910. No 14380 B.

Pipe Corrosion.

Deoxidizing Water to Prevent Corrosion of Steel Mains. An account of an investigation instituted by the Australian Government to determine the best methods for checking the corrosion of the steel mains of the Coolgardie water-works and the recommendations. 2500 w. Eng Rec—May 21, 1910. No. 14154.

Pipe Flow.

Friction Head Hydraulics and Pipe Flow Diagrams. Ernest W. Schoder. Considers the flow of water in pipes from the standpoint of friction head. Mathematical. 2200 w. Cornell Civ Engr—May, 1910. No. 14308 C.

Pipe Lines.

The Hydrostatic Chord. Raymond D. Johnson. With discussion of its application in the design of large pipes of reinforced concrete. 1500 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14334 F.

Purification.

Some Recent Developments in the Purification of Public Water Supplies. R. S. Lea. Illustrates and describes improvements in apparatus used, in mechanical filters, and in methods of purifying the water supply. 7000 w. Can Soc of Civ Engrs—April 28, 1910. No. 14298 N.

Some Phases of the Water Purification Problem—As Related Especially to Sacramento Conditions. Charles Gilman Hyde. Considers the available sources, the requirements, rapid sand filtration and its efficiency, use of coagulants, sterilization, etc. 8500 w. Cal Jour of Tech—May, 1910. No. 14304.

The Disinfection of Water and Sewage. Earle B. Phelps. Brief review of processes developed and the history of chemical disinfection of water. Also the disinfection of sewage and the cost. General discussion. 7000 w. Pro Engrs' Club of Phila—April, 1910. No. 14271 D.

Reservoirs.

Reconnaissance Method of Determining the Volume of Reservoir Sites. Horace W. Sheley. Gives the writer's method of obtaining such data, claiming greater accuracy than in the usual estimate. 5000 w. Eng Rec—April 30, 1910. No. 13625.

Sterilization.

Sterilization of Water. Messrs Walden and Powell. From a paper before the Am. Water Works Assn. describing experiments and methods at Baltimore, Md. 3000 w. Munic Engng—May, 1910. No. 14274 C.

Water Towers.

A Concrete Water Tower (Chateau d'Eau en Beton armé). Describes a structure at Ixelles, near Brussels. Ills. 1600 w. Génie Civil—April 9, 1910. No 14028 D.

Water Works.

The Ripon Water-Works Decision. Gives an outline of a method of apportioning the expenses. 3000 w. Eng Rec—April 30, 1910. No. 13631.

Reinforced Concrete Water Works Construction. Frank C. Perkins. Illustrations and description of features of the Indianapolis water-works. 1200 w. Sci Am—May 7, 1910. No. 13784.

Wells.

Evolution of Well-Drilling Machinery. John L. Cowan. An account of early methods and the first drilling through solid rock. 2200 w. Min & Sci Pr—May 14, 1910. No. 14132.

WATERWAYS AND HARBORS.

Barge Canal.

Construction of the New York State Barge Canal Through Little Falls. D. A. Watt. An illustrated article describing conditions and work at this point. 4500 w. Eng Rec—May 7, 1910. No. 13796.

Chicago.

The Chicago Harbor Problem. Report of the Committee, A. Bement, Chairman, and Messrs. W. L. Abbott, L. E. Ritter, E. C. Shankland and Willard A. Smith. Also general discussion. 6000 w. Jour W Soc of Engrs—April, 1910. No. 14326 D.

Docks.

A Reinforced Concrete Dock. A. P. Brown. Illustrated description of a recently completed dock at Detroit, Mich. 1200 w. Eng Rec—May 21, 1910. No. 14155.

England.

The Relation of Canals to Railway Transport. S. Whettal. A discussion of the water question in England. 2000 w. Cassier's Mag—May, 1910. No. 13954 B.

Germany.

Waterway Development in Wurtemburg (Württembergergische Grossschiffahrtspläne). H. Werner. A brief review of the Danube-Neckar and Danube-Bodensee canal projects. Ills. 2000 w. Glasers Ann—April 15, 1910. No. 14203 D.

Lighthouses.

Lighthouse Practice in the Netherlands (Eenige Mededeelingen over de nederlandsche Kustverlichting). B. A. Verhey. A general review of coast-lighting practice. Ills. 6000 w. De Ingenieur—April 2, 1910. No. 14248 D.

Locks.

The Canadian Hydraulic Lift Locks Walter J. Francis. Illustrated description of the locks on the Trent Canal system. 3000 w. Engr, Lond—April 20, 1910. Serial. 1st part. No. 13857 A.

See also Concrete, under CONSTRUCTION.

Mississippi River.

An Emergency in the Life of a River. Robert S. Taylor. A discussion of the

Mississippi River below Cairo, giving reasons why the Government should be responsible for its regulation. Maps. 5000 w. Eng News—May 5, 1910. No. 13780.

Panama Canal.

Condensed Facts on the Panama Canal. Information based on the authority of the Isthmian Canal Commission. 2500 w. Engng-Con—May 18, 1910. No. 14120.

Piers.

Coaling Pier at Hampton Roads. Warren O. Rogers. Illustrated description of the large electrically-operated pier at the seaboard-terminal of the Virginia Ry. 1200 w. Power—May 17, 1910. No. 13940.

Pollution.

A British Decision Regarding River Pollution. Concerning an action brought to restrain the discharging of sewage effluent into the river Tame. 2500 w. Eng Rec—April 30, 1910. No. 13627.

The North Shore Channel of the Sanitary District of Chicago. C. R. Dart. Illustrated detailed description of work for the protection from sewage pollution of Lake Michigan, north of Chicago. 6000 w. Eng Rec—May 14, 1910. No. 13903.

Stipulations Between the United States and the Passaic Valley Sewerage Commission Regarding the Discharge of Sewage into New York Bay. 1500 w. Eng News—May 12, 1910. No. 13893.

River Improvements.

The Policy of River and Harbor Improvements. Comments taken from remarks of Senator Burton criticizing the policy of conducting such improvements. 2800 w. Eng Rec—May 14, 1910. No. 13904.

Soil Erosion.

The Behavior of a Stream Carrying Sand and the Effect of Sand on the Measurement of Bottom Velocity. E. C. Murphy. Describes interesting phenomena of sand transportation and discusses the effect on the measurement of bottom velocity. Diagrams. 1500 w. Eng News—May 19, 1910. No. 14123.

St. Lawrence River.

The Problems of Winter Navigation on the St. Lawrence River. H. T. Barnes. Describes some icebreakers and their work, ice-forming problems, keeping channels open, etc., and gives results of the work of the Flood Commission. Ills. 6500 w. Can Engr—May 13, 1910. No. 13934.

Water Powers.

Water Power of the South. H. A. Von Schon. Aims to show that there is sufficient power available to supply all the power needs of Southern manufacturers. Ills. 1700 w. Mfrs' Rec—May 12, 1910. Serial. 1st part. No. 13873.

MISCELLANY.

Building Transfer.

Moving a 200-Ton Pier-Shed on Scows. Illustration and description of the transfer of a large steel shed in New York City. 900 w. Eng Rec—May 21, 1910. No. 14150.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Printing Telegraphs.

Electric Printing Telegraphs in the Berlin Police Headquarters (Der elektrische Spaltenferndrucker im Berliner Polizeipräsidium). Illustrated description. Serial. 1st part. 2000 w. Elektrotechniker—April 25, 1910. No. 14219 D.

Radiotelegraphy.

Wireless Telegraph Apparatus for Contestants of the Glidden Tour. René Homer. Illustrates and describes the arrangements. 1000 w. Sci Am—May 14, 1910. No. 13883.

New Methods of Transmission Employed in Wireless Telegraphy. G. Ferrié. Reviews the methods tried to obtain security, and describes a simple wave meter invented by the author. 1800 w. Elect'n, Lond—May 6, 1910. No. 13963 A.

New Radiotelegraphic Systems (Les nouveaux Procédés de Télégraphie sans Fil). H. Marchand. An illustrated description of the Peukert system. 1500 w. L'Elecn—April 2, 1910. No. 14017 D.

See also Frequency, under MEASUREMENT.

Telegraphy.

Telegraphy and Telephony: Professor Fleming's Postgraduate Lectures. G. B. Dyke. Gives the examination questions submitted by Prof. J. A. Fleming at the close of his lectures, with solutions by the author. 500 w. Elec Engr, Lond—May 13, 1910. No. 14182 A.

Electrostatic Charging of Telegraph Wires by Locomotives. Abstract of an article by R. W. Weightman concerning peculiar electrostatic phenomena. 1500 w. Engr, Lond—April 22, 1910. No. 13736 A.

Telemechanic.

Telemechanic (Télémécanique). J. A. Montpellier. The first part describes the system devised by Baron d'Ivry. Ills. Serial. 1st part. 2000 w. L'Elecn—April 30, 1910. No. 14021 D.

Telephone Lines.

Long Underground Telephone Lines on Pupin System. A. Ebeling. Describes in detail a special series of experiments which seem to show that no hindrance now exists against the placing of telephone cables underground. 4500 w. Elec Wld—May 12, 1910. No. 13916.

Aerial Telephone Lines on the Pupin System. B. S. Cohen. Notes on a paper read by A. Ebeling. Gives particulars of the loading adopted on lines in Germany, and of the results. Ills. 1700 w. Elect'n, Lond—May 6, 1910. No. 13965 A.

Telephone Relays.

A Telephone Relay. S. G. Brown. Describes the present form of the author's telephone relay, which magnifies the feeblest currents about 20 times. Also describes an electric stethoscope. Ills. 4500 w. Inst of Elec Engrs—May, 1910. No. 13959 N.

Telephony.

Some Notes on Telephony. H. Harrison. General information pertaining to telephony which is not readily available. 2200 w. Sib Jour of Engng—May, 1910. No. 14316 C.

Discussion on "Modern Automatic Telephone Apparatus," New York, Feb. 11, 1910. Discussion of the paper of W. Lee Campbell. 8200 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14350 F.

New Telephone Systems (Nieuwere Telefoonstelsels).* C. L. van der Bilt. Describes a number of systems, with illustrations from practice in the Netherlands. Ills. 20000 w. De Ingenieur—April 30, 1910. No. 14259 D.

See also Telegraphy, under COMMUNICATION.

Telephotography.

Telegraphy of Photographs, Wireless and by Wire. T. Thorne Baker. Explains the telectrograph system as used by the *Daily Mirror*, refers to the work of Prof. Korn with selenium cells, and gives particulars of wireless transmission. 5000 w. Elect'n, Lond—April 29, 1910. No. 13844 A.

The Thorne-Baker Tele-Photographic Apparatus. Illustrated description of an instrument for transmitting pictures with and without wires. 1500 w. Sci Am—May 21, 1910. No. 14127.

DISTRIBUTION.

Fault Location.

Simple Tests for Locating Faults in Circuits. W. T. Ryan. Describes simple galvanometer tests. Ills. 500 w. Power—May 24, 1910. No. 14266.

Insulation.

Tests on Mica Tubes. Dr K. Fischer. Abstract translation from *Elec. Zeit.* Gives comparative tests showing the superiority of a new type of mica tube containing no paper and practically no binding material. 800 w. Elect'n, Lond—May 6, 1910. No. 13964 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Single-Phase Commutator Generator. Val. A. Fynn. Characteristics of the synchronous, single-phase, shunt, induction generator with mixed excitation. 3000 w. Elec Wld—May 26, 1910. Serial. 1st part. No. 14391.

Leakage Reactance. J. Rezelman. Gives test results of the reactance of a four-pole stator winding with special end connections, confirming conclusions of an earlier article. Ills. 800 w. Elect'n, Lond—April 29, 1910. No. 13845 A.

Parallel Operation of Three-Phase Generators with Their Neutrals Interconnected. George I. Rhodes. Shows that alternators as usually designed and built are not suited for parallel operation with their neutrals interconnected, but that it seems possible to build generators which can operate properly. 4500 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14346 F.

A. C. Motors.

Calculation of the Overhang Leakage in Three-Phase Motors. Dr. M. Kloss. Abstract of an article in the *Elec. und Maschinenbau.* Shows how the leakage of the coil ends of an induction motor or alternator can be found. 800 w. Elect'n, Lond—April 29, 1910. No. 13846 A.

Adjustable Three-Phase Operation and Its Laws (Die regulierbaren Drehstrom-Getriebe und ihre Gesetze). Frederich Schmidt. Reviews the development of the adjustable three-phase motor. Ills. 6000 w. Elektrotech u Maschinenbau—April 10, 1910. No. 14226 D.

Armatures.

Detection of Faults in Small Motor Armatures. C. Nosrac. Illustrates and describes devices successfully used by the writer. 1300 w. Elec Wld—May 19, 1910. No. 14166.

Commutation.

Commutation Phenomena and Magnetic Oscillations Occurring in Direct-Current Machines. G. W. Worrall. Abstract of a paper before the Birmingham Sec. of the Inst. of Elec. Engrs. Discusses the theory of commutation and describes research work. Ills. 3000 w. Elect'n, Lond—May 13, 1910. Serial. 1st part. No. 14185 A.

Commutation in Direct Current Machines. C. L. Arnold. Read before the Arc Works Engng. Soc., Chelmsford. Discusses methods of suppressing sparking, self-induction, the properties of the brush, etc. Diagrams. 4000 w. Elec Engr, Lond—April 29, 1910. No. 13840 A.

Commutation (La Commutation). Marius Latour. A discussion of the theory of commutation based on recent literature. Ills. 7000 w. Bul Soc Int d Elecns—April, 1910. No. 14047 F.

D. C. Dynamos.

Reconstruction of Direct-Current Machines. W. B. Clayton and James W. Craig. Illustrates and describes the application of commutation poles to motors and generators already installed. 2500 w. Elec Wld—May 5, 1910. No. 13773.

D. C. Motors.

See D. C. Dynamos, under DYNAMOS AND MOTORS.

Iron Losses.

Experimental Investigations on Iron Losses and Mechanical Forces on Windings (Experimentelle Arbeiten. I. Ueber Eisenverluste. II. Ueber mechanische Kräfte an Wickelköpfen). Herr Niethammer. An introduction to Herr Czepek's paper. Ills. 1500 w. Elektrotech u Maschinenbau—April 17, 1910. No. 14228 D.

Comparative Investigations of Iron Losses Due to Single-Phase, Rotary and Magneto-Static Magnetization (Vergleichende Versuche über Eisenverluste durch Wechsel-, drehende und magnetostatische Magnetisierung). R. Czepek. Results of extended experiments. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—April 17, 1910. No. 14229 D.

Vertical Motors.

Vertical Motors, with Special Reference to Bearings (Ueber Vertikalmotoren mit besonderer Berücksichtigung der Lagerkonstruktionen). J. Fischer-Hinnen. Illustrated description of various types. 3500 w. Elektrotech u Maschinenbau—April 24, 1910. No. 14230 D.

ELECTRO-CHEMISTRY.

Electric Furnaces.

Improving the Output and Efficiency of Existing Electric Furnaces. Carl Hering. Describes simple methods and rules by means of which it may be determined whether improvements in electric smelting can be made by changes in the electrodes. 2000 w. Met & Chem Engng—May, 1910. No. 13700 C.

Chemical Reactions at Electrodes. Reston Stevenson. Reviews electrochemical reactions in liquid solutions, particularly in aqueous solutions. 4000 w. Met & Chem Engng—May, 1910. No. 13691 C.

Electrolysis.

The Development of the Theories of Electrolysis and Polarization (Die Entwicklung unserer Kenntnisse über Elektrolyse und Polarisation). M. Le Blanc. A review of their development and present form. Ills. 5200 w. Zeitschr d Oest Ing u Arch Ver—April 29, 1910. No. 14208 D.

Electrometallurgy.

Electric Furnaces in Non-Ferrous Metallurgy. Joseph W. Richards. Discusses in detail the use of electric furnaces in the operations of non-ferrous metallurgy. 2000 w. Met & Chem Engng—May, 1910. No. 13688 C.

Electroplating.

Modern Electroplating Plant. Brief description of the plant at the works of the National Cash Register Co., Dayton, Ohio. Ills. 1500 w. Met & Chem Engng—May, 1910. No. 13699 C.

Laboratories.

The Electrical Testing Laboratories and Electrochemistry. Clayton H. Sharp. Describes in detail the points in the equipment most important for electrochemical work. Ills. 5500 w. Met & Chem Engng—May, 1910. No. 13692 C.

ELECTRO-PHYSICS.

Dielectrics.

The Polarization of Dielectrics in a Steady Field of Force. W. M. Thornton. Abstract of a paper before the Phys. Soc. An account of experiments in the polarization of dielectric ellipsoids and cylinders suspended in a steady electric field. 3000 w. Elect'n, Lond—April 22, 1910. No. 13712 A.

Electrification.

Dependence of the Weight of a Body on Its State of Electrification. L. Southerns. Abstract of a paper read before the Cambridge Phil. Soc. Experimental investigation to detect change of weight due to electrification. Ills. 2000 w. Elect'n, Lond—April 22, 1910. No. 13713 A.

Electrotherapeutics.

High-Frequency Currents in Medicine and in Wireless Telegraphy (Haute Fréquence médicale et Télégraphie sans Fil). M. d'Arsonval. Describes electrotherapeutic devices borrowed from wireless telegraphy. Ills. 5500 w. Bul Soc Int d Elecns—April, 1910. No. 14046 F.

Induction Coils.

On the Effect of Shunting Inductive Coils. G. W. O. Howe. Shows geometrically that although the effective resistance may be increased by shunting a highly inductive coil by a non-inductive resistance, the impedance is not increased. 500 w. Elect'n, Lond—April 22, 1910. No. 13711 A.

Magnetic Properties.

Magnetic Properties of Materials. Charles P. Steinmetz. Arguments on behalf of the theory that magnetic alloys owe their ferro-magnetic properties to some particular constituent or constituents. Also editorial. 1300 w. Elec Wld—May 12, 1910. No. 13917.

Retentivity of Magnet Steels. A summary of results of a series of experiments in Austria. 1500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13997 A.

GENERATING STATIONS.

Accumulators.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE; and Motor Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Central Stations.

Reconstruction of a Country Plant. Parker H. Kemble. Illustrated description work made necessary by the consolidation of two Connecticut companies. 3300 w. Elec Wld—May 5, 1910. No. 13772.

Electricity Supply and Transmission in St. Louis. Illustrated description of the system of the Union Electric Light and Power Company. 6500 w. Elec Rev, N Y—May 21, 1910. No. 14146.

Union Electric Light and Power Company. Illustrated detailed description of the electrical generation and distribution of energy for lighting and motor service in the city of St. Louis and suburbs. Also of the administrative and business methods. 19000 w. Elec Wld—May 19, 1910. No. 14163.

Electrical Department of the Metropolitan Street Railway, New York. An illustrated statement of the most important work accomplished by this department since 1907. 2500 w. Elec Ry Jour—May 21, 1910. No. 14129.

The Danville Central Station System. Illustrated description of the transmission system, power plant, and operating features. 2000 w. Elec Wld—May 26, 1910. No. 14390.

Costs.

Cost of Generating and Distributing Electricity for Lighting and Power, New York Edison Co. An analysis of the cost to the New York Edison Co. which produces nearly 70 per cent of the electricity used for lighting in New York City. 1800 w. Engng-Con—May 11, 1910. No. 13912.

Economics.

Central-Station Output and Productive Economy. Discusses the advantages of a large output, giving comparative results. 2000 w. Elec Wld—May 19, 1910. No. 14162.

Fire Hazards.

Common Fire Hazards of Electric Light and Power Plants. W. J. Canada. Remarks on station construction and on preventable fire hazards in stations. 2200 w. Elec Wld—May 19, 1910. No. 14168.

Hydro-Electric.

A General Review of Hydroelectric Engineering Practice. Frank Koester. Third article of a series giving an illustrated discussion of turbines, water wheels, and mechanical equipment of the power plant. 4000 w. Engineering Magazine—June, 1910. No. 14378 B.

Some Considerations in Selecting Equipment for Hydro-Electric Plants. M. H. Collbohm. Calls attention to points in the design, selection and arrangement of the various parts. 3500 w. Elec Age—April, 1910. No. 13935.

Commercial Aspects of Hydro-Electric Plants (Geschäftliche Aussichten von hydraulisch betriebenen Elektrizitätswerken). W. v. Winkler. Considers the economics of large plants. Ills. 3200 w. Elektrotech u Maschinenbau—April 3, 1910. No. 14225 D.

Economical Utilization of Water Power in Lighting and Power Systems of Large Cities (Die Wirtschaftliche Ausnutzung der Wasserkräfte in den Beleuchtungs- und Kraftverteilungsanlagen grösserer Städte). Herr Norberg-Schulz. A discussion of load factor and power cost. Ills. 3000 w. Die Turbine—April 5, 1910. No. 14090 D.

The Schaghticoke Hydro-Electric Plant (L'Installation hydro-électrique de Schaghticoke, Etats-Unis). Richard Muller. Describes this plant on the Hoosic River and gives results of tests. Ills. 4000 w. Tech Mod—April, 1910. No. 14013 D.

Hydroelectric Plant of the Central Georgia Power Company. Illustrates and describes a plant for developing the power of the Ocmulgee River. 2000 w. Eng Rec—May 14, 1910. No. 13907.

Richmond & Chesapeake Bay Plant. Warren O. Rogers. Illustrated description of a combination water power and steam plant. 1400 w. Power—May 3, 1910. No. 13668.

The Brattleboro Hydro-Electric Plant. Lauriston Fredericks. Illustrated description of a power development on the Connecticut River, utilizing a head of about 15 feet. 1000 w. Cassier's Mag—May, 1910. No. 13949 B.

Hydro-Electric Installations of Sweden. Aubrey V. Clayton. Explains the characteristics of the country and describes typical installations. Ills. 1200 w. Inst of Elec Engrs—April, 1910. No. 13708 N.

An Electric Power Plant on the Löntsch (Elektrizitätswerk am Löntsch). J. Ehrensperger. An exhaustive description of the preliminary investigations and construction of a power development in Switzerland. Ills. Serial. 1st part. 3500 w. Schweiz Bau—April 16, 1910. No. 14087 B.

The Cervara Power Plant and Power Transmission to Narni (Das Kraftwerk Cervara und die elektr. Kraftübertragung nach Narni). L. Pasching. Illustrated description of this plant in Italy. 3500 w. Schweiz Bau—April 2, 1910. No. 14085 B.

Cassibili Electric Power Works, Sicily. Illustrations, with brief description of a recent hydro-electric plant. 500 w. Engr, Lond—May 6, 1910. No. 13983 A.

Isolated Plants.

Electric Power at Messrs. Cammell, Laird & Co.'s Trammere Works. Illustrated detailed description. 1500 w. Elec Rev, Lond—May 13, 1910. No. 14184 A.

New Plant at Birchenwood Collieries, Kidsgrove. Illustrated description of an electrical plant for the surface auxiliaries, and to a large extent for power underground. 2 plates. 2500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13730 A.

Load Factors.

Average and Maximum Loads. Alton

D. Adams. A discussion of average and maximum loads in stations of various capacity. Also editorial. 2500 w. Elec Wld—May 19, 1910. No. 14167.

Protective Devices.

See same title, under TRANSMISSION.

Switchboards.

The Evolution of the Switchboard: Twenty Years Progress. Saul Lavine. Abstract of a paper read before the Pittsburg Elec. Boosters' Club. The present number considers the early skeleton switchboard and the ornamental switchboard. 1000 w. Elec Rev, N Y—May 14, 1910. Serial. 1st part. No. 13930.

High-Tension Concrete Switchboard Structures. W. R. Stinemetz. Gives conclusions from the standpoint of the erection engineer. 3000 w. Elec Jour—May, 1910. No. 14288.

Switchgear.

High-Tension Switchgear, with Special Reference to Mining and Colliery Developments. M. B. Field. Abstract of a paper read before the S. Wales Inst. of Engrs. Illustrates and describes types, explaining the uses for which they are suited. 6500 w. Ir & Coal Trds Rev—May 6, 1910. No. 14100 A.

The Koula Switch Gear for Direct-Current Public Lighting (Fernschalter für öffentliche Beleuchtung in Gleichstromzentralen, System Koula). Describes a system recently patented in Austria. Ills. 2000 w. Elektrotech u Maschinenbau—April 24, 1910. No. 14231 D.

Voltage Regulation.

Automatic Voltage Regulators for Direct and Alternating-Current Plants (Die selbsttätigen Spannungsregler für Gleichstrom- und für Wechselstrom-Kraftwerke). J. Schmidt. Describes and discusses various types. Ills. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14237 D.

LIGHTING.

Arc Lamps.

Progress in High-Intensity Electrical Illumination (Neue Aussichten in der elektrischen Starklichtbeleuchtung). Konrad Norden. Describes recent developments in arc lamps. Ills. 7000 w. Glasers Ann—April 1, 1910. No. 14201 D.

See also Street, under LIGHTING.

Illumination.

The Distribution of Artificial Light. Frank Marshall Scantlebury. Abstract of paper read before the Nat. Assn. of Cotton Mfrs., Boston. Describes lamps most generally used, discussing reflectors, etc. 2000 w. Elec Rev, N Y—May 7, 1910. Serial. 1st part. No. 13787.

The Luminous Efficiency of Incandescent Lamps. W. W. Coblentz. The emissivities of filaments are considered from the standpoint of their reflectivities. 2500 w. Elec Wld—May 19, 1910. No. 14169.

Calculation of Illumination by the Point-by-Point Method. Alfred A. Wohlauer. Refers to the paper by Albert F. Parks on the graphical method of calculating, and gives a simpler way developed by the author. 1200 w. Elec Wld—May 12, 1910. No. 13919.

The Bearing of Reflection on Illumination. A. S. McAllister. Theoretical considerations relating to the limits of reflection as disclosed by the absorption-of-light method of calculating illumination. Also editorial. 3000 w. Elec Wld—May 26, 1910. No. 14393.

Reflectors for Incandescent Lamps. Thomas W. Rolph. Explains the advantages of reflectors and gives considerations in regard to their use. 3000 w. Elec Jour—May, 1910. No. 14285.

Show Window Illumination. J. R. Cravath. Shows the waste due to inefficiency of reflecting surfaces, poor reflectors or those unsuited to the purpose. Ills. 1500 w. Cent Sta—May, 1910. No. 13938.

Notes on Office Lighting. C. E. Clewell. Describes experiment, for the purpose of determining the arrangement and number of lamps required to furnish the best illumination. 2000 w. Elec Jour—May, 1910. No. 14286.

Incandescent Lamps.

A Convenient Lamp Bank for Testing Purposes. R. H. Fenkhausen. Illustrates arrangements to give different voltages. 600 w. Power—May 17, 1910. No. 13942.

See also Transformers, under TRANSMISSION.

Photometry.

The Direct Measurement of Mean Spherical Candle-Power by Diffusion Methods. W. E. Sumpner. Abstract of a paper before the Ill. Engng. Soc. Discusses the action of the Ulbrecht globe and its accuracy, comparing with a rectangular box surrounding the lamp and lined with white reflecting surface. 1800 w. Elect'n, Lond—April 22, 1910. No. 13715 A.

Searchlights.

See Military, under MECHANICAL ENGINEERING, AUTOMOBILES.

Street.

An Analysis of Illumination Requirements in Street Lighting. Arthur J. Sweet. A study of distribution, and of glare effect as applied to street lighting. Ills. 6000 w. Jour Fr Inst—May, 1910. No. 14293 D.

Improvements in Street Lighting Units. Dudley A. Bowen. Explains the results obtained by use of the flaming arc. Ills. 1200 w. Elec Jour—May, 1910. No. 14291.

Street Lighting by High Candle-Power Metal Lamps. Information from various sources concerning experience with metal filament lamps. 3000 w. Elect'n, Lond—April 22, 1910. No. 13714 A.

Street Lighting by Modern Electric Lamps. Haydn T. Harrison. Explains conditions to be met in the early installations for street lighting by electricity, referring to results at Marylebone, and the improvements possible with modern electric lamps. 6500 w. Inst of Elec Engrs—May, 1910. No. 14351 N.

MEASUREMENT.

Frequency.

Frequency and Wave-Length Measurements in Wireless Telegraphy and Telephony (Frequenzmesser und Messung der Wellenlänge in der drahtlosen Telegraphie und Telephonie). Eugen Nesper. Describes instruments and methods. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—April 10, 1910. No. 14227 D.

Instruments.

Ferrié and Carpentier Ohmmeters (Ohmmètres, Système Ferrié et Carpentier). J. A. Montpellier. Illustrated description of the instruments and their use. 1500 w. L'Elecn—April 16, 1910. No. 14019 D.

Meters.

Selecting a Watt-Hour Meter. Abstract of bulletin issued by a German firm on the subject of selection by competitive tests. Ills. 2000 w. Elec Wld—May 12, 1910. No. 13918.

Motor Testing.

The Differential Method of Testing a Direct-Current Motor for Temperature Rise and Efficiency (Die Differential-oder Zurückarbeitungsmethode zur Bestimmung der Erwärmung und des Wirkungsgrades einer Gleichstrommaschine). W. Lulofs. Describes and discusses the loading-back test. Ills. Serial. 1st part. 1400 w. Elektrotech Rundschau—April 7, 1910. No. 14221 D.

Wave Length.

See Frequency, under MEASUREMENT.

POWER APPLICATIONS.

Heating.

Recent Progress in the Construction and Application of Electrical Apparatus for Heating and Cooking (I recenti Progressi nella Costruzione e nelle Applicazioni degli Apparecchi elettrici per Riscaldamento e per Cucina). S. Herzog. Describes recent apparatus. Ills. Serial. 1st part. 2500 w. Industria—April 10, 1910. No. 14030 D.

Military.

The Applications of Electricity to Field Engineering. Col. R. E. B. Crompton. Abstract of a lecture at the Roy. Engrs' Inst. Briefly considers applications for army signalling; camp lighting, searchlights, etc.; and for power. 2500 w. Elect'n, Lond—May 6, 1910. No. 13966 A.

Theatres.

The Boston Opera House. Description of the elaborate electrical euipment. Ills. 5000 w. Elec Wld—May 12, 1910. No. 13914.

TRANSMISSION.

Alternating Current.

Paralleling Large Alternating-Current Systems. P. M. Lincoln. Considers the problem of furnishing a small amount of power from one A. C. system to another 3500 w. Elec Jour—May, 1910. No. 14289.

Three-Wire Alternating Current Circuits. Cecil P. Poole. An illustrated article showing the difference between single-phase three-wire, two-phase three-wire, and three-phase three-wire circuits. 2200 w. Power—May 10 1910. No. 13821.

Cables.

Electric Cables. F. Ferine. Considers the general phenomena of electrolysis and discusses in detail the corrosion of lead-covered cables and armored cables and the effectiveness of earthing. 3300 w. Elect'n, Lond—May 13, 1910. Serial. 1st part. No. 14186 A.

Capacity.

Capacity in Transmission Lines. H. F. Penney, R. H. Harrison, G. H. Crawford, Jr. A comparison of the various approximate assumptions of the distribution of capacity in transmission lines. 1500 w. Sib Jour of Engng—May, 1910. No. 14319 C.

Ground Detectors.

Lamp Ground Detectors for Power Circuits. J. M. Row. Illustrates four different methods of connection. 500 w. Power—May 10, 1910. No. 13822.

Insulators.

Transmission Insulators. A. S. Watts. Detailed comparison of high-tension insulators of American and European design. Ills. 500 w. Elec Wld—May 19, 1910. No. 14165.

Lightning Protection.

Lightning and Lightning Protection. Dr. Charles P. Steinmetz. An illustrated article describing the means of protecting lines and station apparatus. 2500 w. Cent Sta—May, 1910. No. 13937.

Line Design.

The Calculation of Transmission Lines (Méthode de Calcul d'une Ligne de Transmission d'Energie électrique). A. R. Garnier. Works out a complete numerical example. Serial. 1st part. 1500 w. L'Elecn—April 23, 1910. No. 14020 D.

Poles.

Concrete Poles for a Transmission Line. Illustrates and describes the design, construction and methods used for a 30,000-volt transmission line at Marseilles, Ill. 2200 w. Engng Rec—May 21, 1910. No. 14152.

Supports for Transmission Lines. C. T. Wilkinson. Illustrated discussion of some mechanical aspects of flexible tower construction. 2000 w. Elec Wld—May 19, 1910. No. 14164.

Protective Devices.

The Protection of High-Tension Alternating-Current Machinery and Cables. Illustrates and describes the more modern methods adopted to ensure a reliable supply of electrical energy. 2000 w. Mech Wld—May 6, 1910. Serial. 1st part. No. 13972 A.

Resonance.

Resonance in Alternating Current Circuits. J. Dalemont. Explains the term and where the phenomena is likely to be met, and its effects. Diagrams. 2000 w. Can Soc of Civ Engrs—1910. No. 14300 N.

Transformers.

Observation of Harmonics in Current and in Voltage Wave Shapes of Transformers. John J. Frank. An illustrated report of a series of tests and investigations with the oscillograph. 7000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14347 F.

Transformer Currents in Weakened Deltas. Nicholas Stahl. Considers arrangements for stated cases. Diagrams. 1500 w. Elec Wld—May 26, 1910. No. 14392.

Magnetic Leakage in Transformers. E. G. Reed. Considers its effect on their regulation under normal and special conditions. Ills. 3500 w. Elec Jour—May, 1910. No. 14290.

Notes on the Design of Autotransformers. A. H. Avery. Notes on their design and manufacture, from the viewpoint of works' costs. 1200 w. Prac Engr—May 6, 1910. No. 13968 A.

Transformers for Metallic Filament Lamps. Information concerning types of transformers that may be employed, their efficiency and cost. 2000 w. Engr, Lond—April 22, 1910. No. 13734 A.

Wires.

Bare Aluminium Conductors. Illustrates and describes methods recommended for jointing and connecting. 1400 w. Engr, Lond—May 13, 1910. No. 14255 A.

MISCELLANY.

Electric Clocks.

Electric Clocks (Notes sur l'Horlogerie électrique). Léopold Reverchon. Describes types of direct-acting electromagnetic clocks. Ills. 1500 w. L'Elecn—April 9, 1910. No. 14018 D.

Insulating Materials.

Disruptive Strength with Transient Voltages. Joseph L. R. Hayden and Charles P. Steinmetz. An investigation, giving some results found with air and with dry white paraffine oil. Ills. 5000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14348 F.

Japan.

Electricity in Japan. Shiro Sano. Brief review of development and progress. 1000 w. Sib Jour of Engng—May, 1910. No. 14318 C.

Rubber.

The Present Situation in Rubber. Gustave Heinsohn. A study of the relations between production and consumption. 3000 w. Cassier's Mag—May, 1910. No. 13945 B.

INDUSTRIAL ECONOMY.

Cost Systems.

Foundry Cost Systems (Zur Frage der Selbstkostenberechnung und Klassierung von Gussstücken). Engelbert Leber. Discusses methods of determining the cost of castings. Ills. Serial. 1st part. 2600 w. Stahl u Eisen—April 6, 1910. No. 14051 D.

Education.

Limitations of Efficiency in Engineering Education. George Fillmore Swain. Address at Union University, Schenectady, N. Y., at the opening of a new engineering building. An able discussion of engineering education. 9000 w. Eng News—May 12, 1910. No. 13890.

The Preliminary Training of Engineers. R. H. Smith. Brief discussion of what to teach? Whom to teach? and who should teach? 3000 w. Engr, Lond—April 22, 1910. No. 13731 A.

Engineering Shop Practice; Its Relation to Manual Training. Fred Duane Crawshaw. Analyzes the present situation in manual training schools and outlines shop courses of an engineering as well as mechanical character. 4500 w. Technograph, No. 24—1909-10. No. 14371 N.

Engineering Education in France and Abroad (La Formation des Ingénieurs en France et à l'Etranger). André Pelletan. A critical review of methods of technical education. 8500 w. Rev Gen d Sci—April 15, 1910. No. 14011 D.

The German Administrative Engineer (L'Ingénieur administratif Allemand). Maurice Bellom. Discusses provisions in Germany for educating engineers to fill administrative positions. 2000 w. Tech Mod—April 1910. No. 14016 D.

Schools of Marine Engineering and Navigation, in Continental Europe. W. H. Dooley. An account of the work in Holland, Prussia and Germany. 2500 w. Int Marine Engng—April, 1910. No. 12814 C.

Engineering.

The Valuation and Remuneration of Technical Knowledge (Die Wertung der technischen Intelligenz und die Verwertung des technischen Könnens). W. Franz. A discussion of engineering as a profession. 5500 w. Tech u Wirt—April, 1910. No. 14245 D.

Engineering Societies.

The Institute of Operating Engineers. Editorial discussion of a proposed new organization. 2000 w. Power—May 24, 1910. No. 14267.

Exhibitions.

The Brussels Exhibition. First of a series of articles describing briefly the exhibits and their arrangement. 2000 w. Engr, Lond—May 13, 1910. Serial. 1st part. No. 14252 A.

The Brussels Exhibition, 1910 (Weltausstellung Brüssel 1910). Begins a general review of the project. Ills. Serial. 1st part. 2000 w. Elektrotech Rundschau—April 7, 1910. No. 14220 D.

Inventions.

The Development of Inventions. Arthur Pestel. A systematic study of the different methods. 2500 w. Cassier's Mag—May, 1910. No. 13953 B.

Labor Insurance.

The Pension and Insurance Law of April 5, 1910 (La Loi du 5 Avril 1910 sur les Retraites ouvrières et paysannes). Maurice Bellom. A review of recent labor legislation in France. 4500 w. Génie Civil —April 23, 1910. No. 14031 D.

Management.

Modern Methods of Shop Management. Frederick A. Waldron. Read before the Nat. Metal Trds. Assn. A discussion of factory management to meet modern conditions. 2500 w. Ir Trd Rev, May 5, 1910. Serial. 1st part. No. 13765.

The Twelve Principles of Efficiency and the Organization that Makes Their Application Possible. Harrington Emerson. First of a series of articles showing the successful working of these principles in historic examples. 4000 w. Engineering Magazine—June, 1910. No. 14376 B.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. This second article of a series considers the handling of stores and prevention of waste. 2500 w. Engineering Magazine—June, 1910. No. 14383 B.

How the Foreman Can Promote Shop Efficiency. Articles by William G. Reyer, George H. Roberts, and J. S. Sheafe discussing this subject. 5000 w. Ry Age Gaz —May 6, 1910. No. 13812.

The Organization of Industrial Works: A German Engineering View of the Question. Gives the substance of two articles by Herr Benno Orenstein, published in the *Frankfurter Zeit.* 4000 w. Ir & Coal Trds Rev—April 29, 1910. No. 13866 A.

Patents.

A Discussion of Leopoldo Salazar's Paper on the McArthur-Forest Cyanide Patents in Mexico; and the Lessons to be Learnt from the History of this Subject. John Malcolm Nicol. 3000 w. Can Min Jour—May 1, 1910. No. 13686.

Storeskeeping.

Railway Storekeepers' Association Gives abstracts of some of the papers presented. 9000 w. Ry Age Gaz—May 20, 1910. No. 14141.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. Fifth and concluding article of this series studying work, wages and profits. 3500 w. Engineering Magazine—June 1910. No. 14377 B.

The Compensation of Workmen. H. L. Gantt. Read before the Nat. Metal Trds. Assn. Suggestions for the training of workmen and paying for efficiency. 1500 w. Ry Age Gaz—May 6, 1910. No. 13815.

Premium Systems. Carl G. Barth. From an address before the Nat. Metal Trds Assn. A general discussion of their application to machine shops. Ills. 2000 w. Ir Age—May 5, 1910. No. 13747.

The Cost of Work. G. W. Dickie. From a paper read before the Tech. Soc. of the Pacific Coast. Discusses the "bonus system" and the limits of its application, and suggests a system to meet conditions on the Pacific Coast. 3000 w. Mech Wld—May 13, 1910. No. 14193 A.

Wage Payment Systems. John Anderson. Discusses how to secure maximum efficiency of labor. 2200 w. Ir Age—May 10, 1910. No. 14110.

MARINE AND NAVAL ENGINEERING.

Battleships.

The Fighting Power of Battleships Archibald S. Hurd. An illustrated review showing the changes in naval artillery and describing modern gun-power development. 3500 w. Cassier's Mag—May, 1910. No. 13946 B.

The United States Battleship Florida. Illustrations of the launching of the newest and largest vessel in the U. S. Navy. Engineering Magazine—June, 1910. No. 14381 B.

Launch of the "Florida." Illustration and brief description of the second of the two largest battleships yet built in the United States. 1200 w. Sci Am—May 7, 1910. No. 13783.

His Majesty's Battleship "Hercules." Details of Launching Ways. Illustrated description of a vessel of the Dreadnought class. 1200 w. Engng—May 13, 1910. No. 14194 A.

Cruisers.

Comparative Trials of Scout Cruisers.—Birmingham—Salem—Chester. Report of the Board appointed by the Navy Department, explaining the object and describing tests. 2000 w. U. S. Navy Dept—Dec. 22, 1909. No. 14355 N.

The German Cruiser Von der Tann. Illustration, with brief description. 700 w. Engr, Lond—May 13, 1910. No. 14254 A.

Dredges.

Gold Dredgers. Illustrates and describes types built in England. 1500 w. Int Marine Engng—May, 1910. No. 13751 C.

15-Yard Dipper Dredge. Explains the advantages of the dipper dredge, and gives illustrated description of the "Toledo," built for work in Boston harbor. 2500 w. Int Marine Engng—May, 1910. No. 13750 C.

New Bucket Dredgers for the Kaiser Wilhelm Canal. Illustrated description of the largest type of bucket dredgers afloat. 2500 w. Int Marine Engng—May, 1910. No. 13753 C.

The Bucket and Pump Dredger Braila. Illustrated description of a dredger for use on the Danube River. 1200 w. Int Marine Engng—May, 1910. No. 13752 C.

An Electrically-Operated Suction Dredger. William T. Donnelly. Illustrated description of a new type. 1200 w. Int Marine Engng—May, 1910. No. 13754 C.

Mammoth Clay Cutting Suction Reclamation Dredgers. Illustrated description of dredgers built for India. 1200 w. Int Marine Engng—May, 1910. No. 13755 C.

Ferryboats.

The Ferryboats "Villa" and "Reggio" of the Italian State Railways (I Ferry-boats "Villa" e "Reggio" delle Ferrovie Italiane dello Stato). Describes vessels for service across the Strait of Messina. Ills. 1500 w. Ing Ferro—April 16, 1910. No. 14044 D.

Fishing Steamers.

German Types of Fishing Steamers (Die deutschen Fischdampfertypen). P. Knipping. A brief review of various types. Ills. 3500 w. Schiffbau—April 13, 1910. No. 14083 D.

Gun Foundations.

The Calculation of Gun Foundations (Berechnung als Grundlage der Konstruktion von Geschützunterbauten). Herr Pietzker. An extended mathematical discussion. Ills. Serial. 1st part. 4500 w. Schiffbau—April 27, 1910. No. 14084 D.

Houseboats.

How to Build a Houseboat for $300. Frederick K. Lord. Plans and directions for the construction of a comfortable boat that will house four or five people. 2000 w. Sci Am—May 14, 1910. No. 13887.

Ice Breakers.

See St. Lawrence River, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Motor Boats.

The Second International Motor Boat and Motor Exhibition in Berlin, 1910 (Die II. Internationale Motorboot- und Motoren- Ausstellung Berlin 1910). Herr Laudahn. A brief review of the exhibits. Serial. 1st part. 4000 w. Schiffbau—April 13, 1910. No. 14082 D.

Conversion of a Steamer on Zurich Lake to Diesel-Motor Power (Umbau eines Personendampfbootes auf dem Zurichsee für Dieselmotorenbetrieb). Describes the reconstruction and the new equipment. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14234 D.

Propellers.

A Discussion of the Propeller Problem (Zur Lösung der Propellerfrage). Herr Rothe. An examination of recent contributions to propeller literature. Ills. 4200 w. Die Turbine—April 5, 1910. No. 14089 D.

Salving.

Salving a Stern-Wheeler. R. M. Reynolds. Describes the salving of the "Sultan," on the Niger River in Africa. 2000 w. Marine Rev—May, 1910. No. 14105.

Shipbuilding.

Recent Developments in Shipbuilding. Benjamin Taylor. A review of merchant shipbuilding during the past year. 6500 w. Cassiers Mag—May, 1910. No. 13952 B.

The Forges et Chantiers de la Méditerranée. Illustrated description of the Le Seyne shipbuilding yard of this company, and its equipment and work. 5000 w. Engng—April 22, 1910. Serial. 1st part. No. 13727 A.

Shipbuilding in 1909 (Scheepsbouw in 1909). J. H. Beucker Andreæ. Has particular reference to the industry in the Netherlands. 11000 w. De Ingenieur—April 9, 1910. No. 14249 D.

Ship Design.

The Most Advantageous Location of Bulkheads for Ships Designed for Light Homogeneous Cargoes (Die rechnerische Ermittelung der günstigsten Schottlage für Dampfer mit leichter homogener Ladung). H. Herner. A mathematical method of determination is given. Ills. 3000 w. Schiffbau—April 13, 1910. No. 14081 D.

Steamboats.

The Most Economical Type of Boat for Operation on Western Rivers with an 8-Ft. Channel Depth. John M. Sweeney. The stern paddle wheel is considered the type best adapted to the western rivers of the United States. Reviews early designs and developments. Also editorial. Ills. 8500 w. Eng News—May 5, 1910. No. 13774.

Steam Engines.

See Superheating, under MECHANICAL ENGINEERING, Steam Engineering.

Steamships.

European Ore Carrying Steamships. Illustrated description of a vessel built for iron ore transport. 1700 w. Marine Rev—May, 1910. No. 14103.

Steam Turbines.

The Design of Manoeuvring Gear for Marine Steam Turbines. Diagrams and descriptions representing the principles of the systems fitted for the different arrangements of turbine machinery now generally adopted in marine practice. 1700 w. Engr, Lond—May 13, 1910. No. 14250 A.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Agricultural.

See Tractors, under Automobiles.

Axles.

Arched versus Straight Axles. R. W. Harvey Bailey. Investigates claims made for arched axles and concludes the only gain is in appearance. 1200 w. Autocar—April 23, 1910. No. 13706 A.

Carbureters.

Making Fuel Economy Tests. Albert L. Clough. Describes tests to determine whether better fuel economy is secured by the installation of a new carbureter. 2500 w. Horseless Age—May 18, 1910. No. 14136.

Cartercar.

Cartercar. Illustrated description of this friction-driven car. 2000 w. Automobile—May 19, 1910. No. 14131.

Commercial Vehicles.

Motor Vehicles Applied to Railroad Service. T. V. Buckwalter. Excerpt from paper read before the Engng Club of Altoona, Pa. Presents the advantages obtained by the Penn. R. R. by the use of these vehicles. 1500 w. Com Veh—May, 1910. Serial. 1st part. No. 13660 C.

Motor Vehicles for Newspaper Delivery. Arthur E. A. M. Turner. Information concerning the delivery service in London, the types employed and cost of operation. Ills. 1200 w. Com Veh—May, 1910. No. 13659 C.

Prussian Regulations Governing the Use of Motor Trucks on Highways (Motorlastwagen und Schutzvorschriften fur Chausseen in Preussen). Gives the text of regulations designed to preserve the roads. 6000 w. Zeitschr d Mit Motorwagen Ver—April 15, 1910. No. 14007 D.

See also Competitions, under Automobiles.

Competitions.

The French Commercial Vehicle Competition in 1909 (Der französische Nutzwagen-Wettbewerb im Jahre 1909). Reports the results of the tests in a series of tables. 4000 w. Zeitschr d Mit Motorwagen Ver—April 15 1910. No. 14008 D.

Darracq.

The Latest Darracq Production. An illustrated article dealing with the main frame of single-piece construction, transmission gear details, and novel points connected with the engine. 1500 w. Auto Jour—May 14, 1910. No. 14181 A.

Electric.

Design for a Garage Charging Board. R. V. Sutliffe. Brief illustrated description of a suitable battery charging board and detailed directions for its use. 2000 w. Horseless Age—May 11, 1910. No. 13923.

Garages.

Heating, Ventilating and Mechanical Equipment of a Garage. Charles L. Hubbard. An explanation of the requirements and equipment of the complete garage. Ills. 9500 w. Horseless Age—May 4, 1910. No. 13824.

Municipal Garage Regulations. Gives ordinances of various cities aiming to reduce the fire risk. 3000 w. Horseless Age—May 4, 1910. No. 13831.

White Company's Garage in New York City. Brief illustrated description. 1200 w. Horseless Age—May 4, 1910. No. 13825.

Babcock Electric Vehicle Garage, Cleveland, Ohio. Describes building, storage room, charging plant, and features of service. Ills. 1800 w. Horseless Age—May 4, 1910. No. 13826.

Cincinnati Garages. Illustrated descriptions of the garages of the different companies in various parts of the city. 2500 w. Horseless Age—May 4, 1910. No. 13827.

Elmwood Garage, Providence, R. I. Illustrated description. 2500 w. Horseless Age—May 4, 1910. No. 13828.

Garage of Pacific Motor Car and Aviation Company, Los Angeles. Illustrated description of a large establishment in Southern California. 2000 w. Horseless Age—May 4, 1910. No. 13829.

Garage Business in Grand Rapids, Mich. Brief descriptions of the garages now available. Ills. 2000 w. Horseless Age—May 4, 1910. No. 13830.

Ignition.

The Magneto—Why It Makes Sparks. Herbert L. Towle. Explains the behavior of a magneto. Ills. 1500 w. Automobile—May 5, 1910. Serial. 1st part. No. 13771.

Lancia.

The 24 h. p. Four-Cylinder Lancia. Illustrated detailed description of a car having an excellent lubrication system and many features of interest. 1500 w. Autocar—April 23, 1910. No. 13707 A.

Military.

The Use of Motors for the Transport of Troops. T. Clarkson. A report of experiments with double-deck cars, followed by general discussion. 10000 w. Jour Roy U S Inst—April, 1910. No. 14280 N.

An Automobile Carrying an Electric Searchlight for the French Army (Projecteur électrique automobile de l'Armée française). Ch. Dantin. Illustrated description of the car and its equipment. 2500 w. Génie Civil—April 16. 1910. No. 14029 D.

Motor Power.

The Effect of Speed and Load on Power and Fuel Consumption. A study of the characteristics of petrol engines in regard to power, speed and fuel consumption. 2000 w. Auto Jour—April 23, 1910. No. 13705 A.

Motors.

One-Crank Radial Cylinder Engines. Archibald Sharp. Discusses the question of balance. Ills. 1800 w. Autocar—May 14, 1910. No. 14180 A.

Motor Tests.

Characteristic Curves of Petrol Engines. Brief description of a test on a petrol motor wagon weighing little over three tons. 600 w. Engr, Lond—May 6, 1910. No. 13979 A.

Noises.

Unnecessary Noises in Motor Car Operation. Albert L. Clough. Suggestions for preventing them. 1500 w. Horseless Age—May 11, 1910. No. 13922.

Omnibuses.

The Renewal of the Concession to the Omnibuses and Municipal Tramways in Paris (Le Renouvellement de la Concession des Omnibus et des Tramways municipaux, à Paris). A. Le Vergnier. A discussion of the importance of motor omnibuses in the transportation facilities of Paris. Ills. 3500 w. Génie Civil—April 2, 1910. No. 14024 D.

Packard.

Packard Nineteen Hundred and Eleven. Illustrated descriptions of new models. 3000 w. Automobile—May 19, 1910. No. 14130.

Peugeot.

A Twin-Cylinder "Lion" Peugeot Car. Illustrated description of this 12 h. p. model. 700 w. Auto Jour—April 30, 1910. No. 13839 A.

Shops.

See same title, under MACHINE WORKS AND FOUNDRIES.

Sizaire.

The Four-Cylinder Sizaire. Illustrated description of the chassis of this new car. 1100 w. Auto Jour—April 23, 1910. No. 13704 A.

Sleighs.

Two Novel Motor Sleds. Walter Langford. Illustrates an application of the pedrail system being constructed for Capt. Scott to use in his dash to the South Pole. Also gives illustrated description of a very different design successfully used in Sweden. 1200 w. Sci Am—May 14, 1910. No. 13884.

Steering Gears.

Laying Out Steering Gears for Automobiles. John L. Barra. A theoretical investigation. 1400 w. Mach, N Y—May, 1910. No. 13646 C.

Tractors.

Steam Ploughing Engine and Tractor at the Brussels Exhibition. Brief illustrated descriptions. 500 w. Engng—May 6, 1910. No. 13978 A.

Transmissions.

The Silent Chain. F. E. Watts. Describes the construction and use of chains of this type. Ills. 2000 w. Horseless Age—May 18, 1910. No. 14135.

Eccentric-Crank Mechanism in Automobiles (Untersuchung des Einflusses der Desachsierung bei Automobilmotoren). Walther Freiherr v. Doblhoff. An exhaustive mathematical discussion of this type of transmission. Ills. Serial. 1st part. 2000 w. Motorwagen—April 30, 1910. No. 14200 D.

White.

White Steam and Gasoline Cars for 1911. Illustrates and describes new models. 2500 w. Horseless Age—May 11, 1910. No. 13924.

COMBUSTION MOTORS.

Aeronautic Motors.

Recent Progress in Motors for Aeroplanes. W. F. Bradley. Illustrates and describes recent high-power, light-weight motors for flying machines. 2500 w. Cassier's Mag—May, 1910. No. 13950 B.

Fuels.

Fuel Quality and Engine Output. Cecil P. Poole. Shows that the power of a gas engine does not vary greatly with the quality of the fuel. Diagrams. 2000 w. Power—May 10, 1910. No. 13823.

Gas-Engine Cylinders.

Gas and Oil Engine Combustion Spaces. James W. Naylor. Gives a brief survey of the conditions to be observed, and a simple method of determining the volume of combustion spaces for gas and oil engines. 1600 w. Engr, Lond—May 13, 1910. No. 14258 A.

Gas Engines.

The Development of the Gas Engine. E. T. Adams. Illustrated descriptions of typical American designs, with information relating to them. 5000 w. Pro W Ry Club—Feb. 15, 1910. No. 14275 C.

Horizontal vs. Vertical Gas Engines. John S. Leese. Compares the main features of the two types. 1200 w. Power—May 17, 1910. No. 13943.

Four-Cylinder High-Speed Gas Engine. Illustrated detailed description of a multi-cylinder, high-speed vertical type. 1200 w. Engr, Lond—April 29, 1910. No. 13864 A.

Gas Engine Using Blast-Furnace Gas at the Barrow Steel Works. Illustrations of three double-acting large gas-engines, with description and information. 1500 w. Engng—April 29, 1910. No. 13853 A.

Gas Power Plants.

The Status of Producer-Gas Power Plants in the United States. Editorial review of Prof. Fernald's report. 1800 w. Eng News—May 5, 1910. No. 13778.

Gas Turbines.

The Inherent Difficulty of the Gas Turbine. R. C. H. Heck. Explains why the gas turbine and the gas engine with combustion at constant pressure have been slow of successful realization. 2000 w. Power—May 3, 1910. No. 13671.

Oil Engines.

The Diesel Oil Engine for Land Work. Peter Stobie. Read before the Greenock Assn. of Engrs. & Shipbldrs. Compares the cycle of the Diesel engine with the Otto cycle and other internal-combustion engines, discussing the advantages. 4000 w. Mech Engr—May 13, 1910. No. 14191 A.

See also Gas-Engine Cylinders; under COMBUSTION MOTORS; and Motor Boats, under MARINE AND NAVAL ENGINEERING.

Pressures.

Mean Pressures in Internal-Combustion Engines. Explains why it is not wise to use extremely high pressures, and describes systems found to be economical. 1500 w. Mech Wld—April 22, 1910. No 13724 A.

HEATING AND COOLING.

Air Humidifying.

Humidifiers, Their Principles and Useful Applications. Sterling H. Bunnell. An illustrated survey of types and their operation. 4000 w. Engineering Magazine—June, 1910. No. 14382 B.

See also Ventilation, under HEATING AND COOLING.

Central Plants.

Central Power and Heating Plant for a Group of School Buildings. Illustrated description of a plant at Brookline, Mass., for heating a manual training school, bath house, municipal gymnasium and high school. 2500 w. Heat & Vent Mag—May, 1910. No. 14305.

See also Power Plants, under POWER AND TRANSMISSION.

Liquid Oxygen.

Commercial Oxygen. Ernest A. Le Sueur. Describes the methods of production, giving a review of early processes. Ills. 3000 w. Met & Chem Engng—May, 1910. No. 13689 C.

Plant Testing.

Investigating a Heating Plant. Charles L. Hubbard. Shows how to make an examination of a proposed plant, or of one in use, how to collect data and deduce practical information. 2000 w. Met Work—May 21, 1910. No. 14142.

Refrigeration.

Artificial Systems of Refrigeration. C. P. Wood. Considers the refrigerants available, especially anhydrous ammonia and carbon dioxide. Also reviews briefly ammonia absorption and compression systems. 3500 w. Power—May 3, 1910. No. 13672.

Steam Heating.

How to Heat a Concrete House. Daniel R. Bacon. Describes how to install a complete steam heating plant, designed to be as inexpensive as possible and give the best results. Ills. 4000 w. Cement Age—May, 1910. No. 14303 C.

Ventilation.

Ventilation and Humidifying in Cotton Mills. W. H. Booth. Explains the need of heat and moisture in cotton spinning, and systems for securing the right conditions. 2000 w. Elec Rev, Lond—April 29, 1910. No. 13842 A.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Water-Driven Centrifugal. Brief illustrated description of exhibits shown at the Brussels International Exhibition. 700 w. Engng—April 22, 1910. No. 13728 A.

Centrifugal Pumps. William R. Wiley. Considers the scope and application of the pump to engineering problems, outlining features of modern practice. General discussion. Ills. 9500 w. Jour W Soc of Engrs—April, 1910. No. 14328 D.

The Theory of Centrifugal Pumps (Zur Theorie der Zentrifugalpumpen). J. Bartl. Mathematical. Ills. Serial. 1st part. 4500 w. Die Turbine—April 20, 1910. No. 14091 D.

Determination of the Velocity of Water in Centrifugal-Pump Piping (Determinacion de la Velocidad del Agua en las Tuberias de las Bombas centrifugas). Roberto Nicole. Mathematical. Ills. 3000 w. Energia Elec—April 25, 1910. No. 14015 D.

The Regulation of Centrifugal Pumps and Compressors (Ueber die Regulierung von Kreiselpumpen und -gebläsen). H. Hoffmann. A theoretical and practical discussion of regulating methods and devices. Ills. Serial. 1st part. 3500 w. Die Turbine—April 5, 1910. No. 14088 D.

See also Tailings Disposal, under MINING AND METALLURGY, Ore Dressing and Concentration.

Eddy Currents.

Eddy Currents as a Factor in Hydrodynamic Theory (Die Bedeutung des hydrodynamischen Wirbelbegriffes). R. Knoller. A discussion of the importance of this factor. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 30, 1910. No. 14096 D.

Pumping Plants.

Raising Water by Its Own Energy. Simpson Rice. Illustrates and describes the equipment of a pumping plant furnished with current from the main station. 3000 w. Power—May 24, 1910. No. 14262.

The Scoop-Wheel Pumping Plant at Schellingwoude, Holland. Charles S. Slichter. Information and illustrated description. 3000 w. Eng News—May 19, 1910. No. 14124.

Pumps.

The Humphrey Pump at the Brussels Exhibition. Illustrated description and report of tests demonstrating the economy of this gas pump. 800 w. Engr, Lond—May 13, 1910. No. 14257 A.

Turbine Design.

A Method of Calculating the Turning Moment of Turbine Machines (Di un Metodo di Calcolo per Determinare il Momento di Rotazione nei Turbo-motori e nei Turbo-operatori). Celeste Malavasi. Mathematical. Examines the cases of turbines and of centrifugal pumps and fans. Ills. 3500 w. Monit Tech—April 30, 1910. No. 14042 D.

Turbine Governing.

The Influence of the Piping on the Regulation of Water Turbines (Der Einfluss der Rohrleitung auf die Regulierung von Wasserturbinen). E. Braun. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1910. No. 14094 D.

Water Wheels.

Some Points in the Design of Impulse-Wheel Buckets. George M. Peek. A mathematical discussion of bucket design. Ills. 1500 w. Eng News—May 5, 1910. No. 13777.

MACHINE ELEMENTS AND DESIGN.

Axles.

Stresses in Axles under Variable and Shifting Load (Ueber die Spannungsverhältnisse in Achsen bei variabler und wandernder Belastung). W. Mader. Mathematical discussion of the stresses in the sheave axle of a mining hoist. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—April 22, 1910. No. 14207 D.

Ball Bearings.

See Shaft Bearings, under Power and Transmission.

Bolts.

See Rivets, under Machine Elements and Design.

Brakes.

The Design of Band Brakes (Systematische Untersuchung und Berechnung der Bandbremsen). H. Al. Siebeck. Mathematical investigation of the principles of their design. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14238 D.

Chains.

Proportions of Chain-Rings. I. Robson. Reports a series of tests on rings of various sizes to determine the safe limit of loading. Gives tabulated results. 1800 w. Engng—May 6, 1910. No. 13973 A.

Gears.

A Novel Reduction Gear. J. A. MacMurchy. Illustrated discussion of the Melville-MacAlpine reduction gear. 3000 w. Ap Sci—April, 1910. No. 14281 C.

Graphical Charts.

The Use of Stereographic Charts and Solid Models. John B. Peddle. Explains methods of laying out charts, and the making of various models. Ills. 3500 w. Am Mach—Vol. 33. No. 19. No. 13875.

Graphic Representation of Functions involving Three Variables (Représentation graphique des Fonctions à 3 Variables). L. Jannin. Describes a method of making graphical charts involving the geometry of three dimensions. Ills. 4500 w. Rev de Mécan—April, 1910. No. 14048 E + F.

Punch Frames.

The Strength of Punch and Riveter Frames Made of Cast Iron. A. Lewis Jenkins. Experimental investigations of the relation between the ultimate strength of curved cast-iron specimens and the ultimate strength of the attached test bars, comparing with results by various methods of analysis. Ills. 3500 w. Jour Am Soc. of Mech Engrs—May, 1910. No. 14330 F.

Rivets.

Designing Eccentrically Loaded Bolt and Rivet Groups. Harry Gwinner. Illustrates the stresses produced by an example, and gives data sheet supplement for facilitating the solution of such problems. 600 w. Mach, N Y—May, 1910. No. 13655 C.

Screws.

A Method of Finding Sizes of Roller Thread Screw Blanks. J. F. Springer. An approximate diameter formula is derived. 1200 w. Am Mach—Vol. 33. No. 21. No. 14380.

Stresses.

Strength of Materials Under Combined Stresses. Arthur Morley. Considers briefly whether it is time to discard established rules used in the design of parts subject to compound stress. 700 w. Engng—April 29, 1910. No. 13855 A.

Valves.

A New Water Pressure Regulating Valve with Electrical Quick-Opening Attachment. Illustrated description of the Anderson water pressure reducing valve with electrical quick-opening attachment. 600 w. Eng News—May 5, 1910. No. 13779.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

How to Use Chloride of Zinc in Melting Aluminum. Explains what it accomplishes as a flux. 700 w. Brass Wld —May, 1910. No. 14171.

See also Brass Founding, under Machine Works and Foundries.

Annealing.

Annealing High Speed Steel in One Hour. C. U. Scott. Describes methods for greatly reducing the time of annealing. 1800 w. Am Mach—Vol. 33. No. 18. No. 13760.

Assembling.

Reorganizing a Run-Down Assembling Department. Alfred Spangenberg. Discusses fundamental principles applicable to all systems. 4500 w. Mach, N Y—May, 1910. No. 13648 C.

Boiler Making.

A Method of Handling Flue Work. C. E. Lester. Illustrates and describes a set of tools and gages, and a standard method of setting flues. 1000 w. Boiler Maker—May, 1910. No. 13920.

Boring Machines.

Vertical Boring and Turning Machine. Illustrated description of a machine shown at the Brussels Exhibition. 800 w. Engng—May 6, 1910. No. 13976 A.

Brass Founding.

The Chemist in the Brass Foundry. W. M. Corse. Explains the value of a chemist in brass foundry work. 1200 w. Met & Chem Engng—May, 1910. No. 13698 C.

Problems of the Brass Foundry. Considers economies effected by the use of molding machines in the production of brass and aluminum castings for automobiles. 1500 w. Foundry—May, 1910. No. 13667.

The Porosity of Brass Castings. C. Vickers. The cause and remedy. Ills. 1000 w. Foundry—May, 1910. No. 13666.

Case Hardening.

Some Recent Investigations on Case-Hardening. Sydney A. Grayson. Read before the I. and S. Inst. An investigation to determine the percentage of carbon diffused into the steel by the use of different compositions, and the effect produced at different temperatures. Ills. 3800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13992 A.

Chain Making.

Automatic Machines Used in the Manufacture of Chain. Illustrates and describes novel devices. 1200 w. Am Mach—Vol. 33. No. 18. No. 13764.

Die Sinking.

Interesting Ways of Making Molds for Glassware Products. E. F. Lake. Die-sinking processes are illustrated and described. 1800 w. Am Mach—Vol. 33. No. 18. No. 13761.

Drilling Machines.

A New American Radial Drill. Illustrated description of a full universal triple-geared pattern. 2000 w. Ir Age—May 19, 1910. No. 14109.

Tests of Another Remarkable High-Speed Radial Drill. H. M. Norris. Illustrated description with tables and charts showing results obtained on various materials. 2000 w. Am Mach—Vol. 33. No. 20. No. 14115.

Enameling.

The Art of Enameling. Harold Holcroft. Read before the Soc. of Chem. Ind. Deals with vitreous enameling of cast iron for industrial purposes. 5000 w. Sci Am Sup—May 7, 1910. No. 13785.

Enameled Cast Iron Sanitary Ware. Dillen Underhill. Illustrated description of the design and construction of the enameling furnace, with a description of the sifter used for applying the enamel. 3000 w. Foundry—May, 1910. No. 13662.

Enamelling on Cast Iron (Ueber die gebräuchlichsten Emaillierverfahren auf Gusseisen). J. Schlemmer. A review of common practice. 1500 w. Giesserei-Zeit—April 15, 1910. No. 14065 D.

Etching.

The Manufacture of Etched Novelties. Illustrates and describes the making of etched brass buckles. 1500 w. Brass Wld —May, 1910. No. 14172.

Forging.

Forging in Old France. Joseph G. Horner. Illustrates and describes shop methods and early tools used in the eighteenth century. 1200 w. Mach, N Y —May, 1910. No. 13647 C.

Flow of Metals in Heading, Cold Forging and Swaging. H. P. Townsend. Illustrates and describes the action of materials handled under various pressures in dies. 4500 w. Am Mach—Vol. 33. No. 20. No. 14116.

Foundries.

The Sulzer Brothers' Foundry in Winterthur (Die Giesserei-Anlagen von Gebrüder Sulzer in Winterthur). Illustrated description of this large plant. Serial. 1st part. 2000 w. Giesserei-Zeit —April 1, 1910. No. 14063 D.

Foundry Coke.

The Chemistry of Coke and Iron Founding (Die Kokschemie unter besonderer Berücksichtigung der Eisengiesserei). Max Orthey. A review of the phenomena of combustion in the cupola, the effect of impurities in coke, etc. Serial. 1st part. 1500 w. Giesserei-Zeit—April 1, 1910. No. 14060 D.

Foundry Flasks.

A Simple Construction for Foundry Flasks handled by Crane (Ueber Kran-Formkasten und deren Herstellung nach vereinfachter Methode). H. Vetter. Illustrates and describes special types. 1600 w. Giesserei-Zeit—April 1, 1910. No. 14064 D.

Foundry Furnaces.

Crucible Steel Casting Process. Carl Smerling. Deals with the design and construction of furnaces for melting crucible steel. Ills. 1200 w. Foundry—May, 1910. Serial. 1st part. No. 13665.

Foundry Management.

See Management, under INDUSTRIAL ECONOMY.

Foundry Practice.

Latter-Day Steel Foundry Practice. Percy Longmuir. Read before the Manchester (Eng.) Assn. of Engrs. Discusses the crucible, open-hearth, side blow converter and electric processes. describes accurate methods for economical output. 1000 w. Am Mach—Vol. 33. No. 19. No. 13877.

erzeugung). J. Sonnenfeld. The first part discusses the acid open-hearth process. Serial. 1st part. 1500 w. Giesserei-Zeit—April 15, 1910. No. 14066 D.

Foundry Practice in Germany (Note sur l'Organisation de quelques Fonderies en Allemagne). M. Portevin. Discussion of features differing from French practice, particularly the treatment of molding sand, the use of molding machines, and the employment of testing laboratories. 1300 w. Rev de Métal—April, 1910. No. 14001 E + F.

Grinding.

Economy in Grinding. John J. Thacher. Illustrates and describes practices observed at the works of the Brown & Sharpe Mfg. Co. 2500 w. Mach, N Y—May, 1910. No. 13653 C.

The Vitrified Grinding Wheel and How It Is Made. Walter C. Gold. Descriptive account. 1200 w. Brass Wld—May, 1910. No. 14174.

Jarring Machines.

The Shockless Jarring Machine. Wilfred Lewis. Explains the principles upon which this labor-saving appliance works and its efficiency in the consumption of power. Ills. 4500 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14335 F.

Lacquering.

The Up-to-Date Method of Applying Lacquers. G. J. Nikolas. Illustrates and describes an apparatus for applying lacquer by means of the air brush or spray. 500 w. Brass Wld—May, 1910. No. 14173.

Lathes.

New Turn Table Lathe of Pratt & Whitney Company. Illustrated description of a lathe for machining bar stock, castings, and forgings. 3000 w. Am Mach—Vol. 33. No. 20. No. 14114.

Molding.

Molding Practice (Aus der Formereipraxis). H. Kloss. A practical discussion of hand molding. Ills. Serial. 1st part. 1200 w. Giesserei-Zeit—April 1, 1910. No. 14061 D.

Molding Cast Steel Drum Shells. H. J. McCaslin. Illustrates and describes a method of producing large steel sections, including a description of the spreading device, core boxes and pattern. 2200 w. Foundry—May, 1910. No. 13661.

Molding Bath Tubs (Formerei von Badenwannen). C. Irresberger. Describes practice in molding by hand and by machine. Ills. 2000 w. Stahl u Eisen—April 6, 1910. No. 14053 D.

Molding Machines.

New Farwell Molding Machines. Illustrated description of pneumatic roll-over machines and squeezers. 1000 w. Ir Age—May 5, 1910. No. 13749.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Pipe Fittings.

Establishing a Commercial Standard for Pipe Fittings. F. W. Barrows. Detailed discussion of changes made to lessen cost. Ills. 5000 w. Mach, N Y—May, 1910. No. 13654 C.

Planers.

The Bateman Planer Drive. Joseph G. Horner. Illustrated description of a separate self-contained driving apparatus to be fitted to old designs of machines. 700 w. Mach, N Y—May, 1910. No. 13649 C.

A Regenerative Electric Drive for Planing-Machines. Illustrated description of driving arrangements, and explanation of considerations determining the choice of system to be adopted. 2000 w. Engng—May 6, 1910. No. 13975 A.

Reamers.

Irregular Spacing of the Cutting Edges of Reamers. Discusses the proper manner to break up the flutes of reamers. Diagrams. 800 w. Mach, N Y—May, 1910. No. 13656 C.

Shop Appliances.

Tools and Fixtures Used in Making Dentists' Appliances. F. A. Stanley. Illustrated description of small tools, jigs, fixtures, gages, etc. 2500 w. Am Mach—Vol. 33. No. 21. No. 14386.

Shop Design.

Metal-Working Plants and Their Machine-Tool Equipment. Charles Day. First of two articles analzing the machine-tool equipment of metal-working plants, especially as influencing the design, layout, and structural features of the buildings. Ills. 3000 w. Engineering Magazine—June, 1910. No. 14379 B.

The General Lay-Out and Equipment of a Complete Set of Engineering Shops for a Modern Colliery, with an Output of About 2000 Tons per Day. William Trimmer. Abstract of paper awarded first prize in the Lewis Prize Competition, 1909. Illustrated description. 3500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13745 A.

Shop Management.

See Management, under INDUSTRIAL ECONOMY.

Shop Practice.

Mass Production in Small Establishments (Massenfabrikation in kleineren Betrieben). Martin H. Blancke. Shows the possibility of obtaining the economy of mass production in small shops. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver —April 15, 1910. No. 14205 D.

Some Ingenious Economies of a Small Shop. T. A. Sperry. Illustrates and describes interesting devices and methods. 1500 w. Am Mach—Vol. 33. No. 18. No. 13762.

Machine Shop Practice. This first article of a series describes turning gas engine pistons in the turret lathe. Supplement. 300 w. Mach, N Y—April, 1910. Serial. 1st part. No. 13645 C.

Machining Vertical Engine Cylinder with Standard. Describes operations with the aim of showing the adaptability of the duplex horizontal boring machine. Ills. 1000 w. Prac Engr—April 29, 1910. No. 13848 A.

Machining a 41 Inch Sluice Valve Body and Plug. J. A. Gray. Illustrates and describes the method of performing the various operations in machining. 1500 w. Am Mach—Vol. 33. No. 21. No. 14388.

Some Machining Operations for Producing Motor Car Parts. Illustrates and 3000 w. Foundry—May, 1910. No. 13664.

Comparative Notes on Steel-Foundry Practice (Erfahrungen und vergleichende

Making the De Vilbiss Pliers. Ethan Viall. Gives in detail each step in the manufacture of pressed steel, cam motion, parallel-jaw pliers in a shop at Dundee, Mich. Ills. 2500 w. Mach, N Y—May, 1910. No. 13651 C.

Methods and Devices Used in Making Dental Vulcanizers. F. A. Stanley. Illustrates and describes interesting methods and devices. 2500 w. Am Mach—Vol. 33. No. 19. No. 13874.

Shops.

The Cincinnati Planer Company's New Plant. Illustrated detailed description of the shop and its equipment. 1200 w. Ir Age—May 26, 1910. No. 14384.

New Plant Where Selden Cars Are Built. Morris A. Hall. Illustrates and describes new factories at Rochester, N. Y., and their equipment for car building. 3000 w. Automobile—May 5, 1910. No. 13770.

Owen Automobile and Methods of Production Involved. Thomas J. Fay. Illustrates and describes the plant building this car, and the main features of the new model. 2500 w. Automobile—May 5, 1910. No. 13769.

Tempering.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Tools.

Examples of Box-Tool Design. F. P. Crosby. Illustrates and describes box-tools of different designs, with examples of the work for which each is intended. 1500 w. Mach, N Y—May, 1910. No. 13652 C.

Welding.

A Present Menace to Autogenous Welding. Editorial on the causes of accidents with this process. 1200 w. Ir Age—May 5, 1910. No. 13746.

The Manipulation of the Oxy-Acetylene Blowpipe. Herbert Luscius Whittemore. Detailed discussion of its use. Ills. 4500 w. Technograph, No. 24—1909-10. No. 14373 N.

Thermit Welding (Ueber das aluminothermische Verfahren). Al. Parma. Describes the process and gives an estimate of its possible uses in mining operations. Ills. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—April 30, 1910. No. 14071 D.

Wood-Working Machinery.

Railway Sleeper Adzing and Boring Machine. Illustrated description of a machine recently built for South American railway requirements. 500 w. Engr, Lond—May 6, 1910. No. 13984 A.

MATERIALS OF CONSTRUCTION.

Alloys.

The Manufacture of Britannia-Metal and Other Soft Metal Sheets; Their Uses and Adaptability. Illustrated description. 2500 w. Brass Wld—May, 1910. No. 14170.

A Recent Advance in the Alloy Industry (Une nouvelle Perspective dans l'Industrie des Alliages). K. Friedrich. Suggests a new method of fabricating alloys. 1400 w. Rev de Métal—April, 1910. No. 14006 E + F.

Alloy Steels.

Some Physical Properties of Two Per Cent Chromium Steels. Andrew McWilliam and Ernest J. Barnes. Read before the I. and S. Inst. A record of results of experimental work on the heat treatment of these steels. Ills. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13900 A.

The Application of Titanium Alloys in the Steel Industry (Ueber Verwendung von Titan-Legierungen in der Stahlindustrie). Wilhelm Venator. Discusses the production and properties of titanium steel, giving results of tests. Ills. 2000 w. Stahl u Eisen—April 20, 1910. No. 14057 D.

Cast Iron.

The Chemistry of Cast Iron. Elmer E. Eakins. Read before the Phila. Found. Assn. Discusses heat treatment and the influence of chemical compounds upon the casting. 3000 w. Ir Age—May 12, 1910. No. 13871.

Physical Properties of Cast Iron. F. J. Cook. Read before the Staffordshire Iron & Steel Inst. Discusses the effect of sand, chills, casting temperature, rate of cooling, etc., upon the structure of gray iron. Ills. 3500 w. Foundry—May, 1910. No. 13663.

Heat Insulation.

An Investigation of Heat-Insulating Materials (Versuche mit Isoliermitteln). Reviews tests on various materials in Bavaria. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14239 D.

Metallography.

Uniform Nomenclature of Iron and Steel. John Oliver Arnold. Read before the I. and S. Inst. Discusses the present views of metallographists and urges the support of Prof. Le Chatelier in his effort to abolish personal names for the constituents of steel. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13994 A.

The Homogeneity of Metals. Gregoire Tagueeff. Read before the I. and S. Inst. Considers the impotrance of studying the structure of metals, and the relation of the structure to the behavior in practice. Ills. 5000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13991 A.

Further Observations on the Segregation of the Various Metalloids in Steel. S. S. Knight. Photomicrographs, and report of research work in the field of silicon-iron compounds. 1500 w. Ir Trd Rev—May 12, 1910. No. 13879.

The Crystallography of the Iron-Carbon System. Adolphe Kroll. Aims to establish generally the relation existing between crystallography and the stability diagram. Ills. 19500 w. Iron & Steel Inst—May, 1910. No. 13996 N.

The Constitution of Cast-Irons and Carbon Steels from the Practical Standpoint. Donald M. Levy. Read before the I .and S. Inst. Considers the relations existing between iron and carbon over practically the whole range of cast irons and carbon steels. 4000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13987 A.

The Chemical and Mechanical Relations of Iron, Manganese, and Carbon. J. O. Arnold and A. A. Read. Read before the I. and S. Inst. An account of experimental investigations. Ills. 2500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13995 A.

The A2 Point in Chromium Steel. Harold Moore. Read before the I. and S. Inst. Gives results of an investigation upon a series of chromium steels in which a remarkable peculiarity was noted. 2800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13988 A.

Steel.

The Elastic Breakdown of Certain Steels. C. A. M. Smith. (Abstract.) Read before the I. and S. Inst. Investigates methods of determining the maximum stress at elastic breakdown. Diagrams. 2500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13993 A.

Tin.

Physico-Chemical Researches on the Contagious Diseases of Metals (Recherches physico-chimiques sur les Maladies contagieuses des Métaux). Ernst Cohen. Discusses corrosion and other troubles in tin. Ills. 8500 w. Rev Gen d Sci—April 30, 1910. No. 14012 D.

A Physico-Chemical Study of Tin (Etudes physico-chimiques sur l'Etain). Ernst Cohen. Reports an investigation of the phenomena of hammer hardening. Ills. 5000 w. Rev de Métal—April, 1910. No. 14003 E + F.

Gray Tin (L'Etain gris). Ernst Cohen. An investigation of the corrosion of tin. Ills. 2000 w. Rev de Métal—April, 1910. No. 14004 E + F.

Tool Steels.

A Research on the Hardening of Carbon and Low-Tungsten Tool-Steels. Shipley N. Brayshaw. Deals with results obtained from two kinds of carbon tool-steel which differed only in that one contained about 0.5 per cent of tungsten. Considers questions connected with workshop hardening. Ills. 28800 w. Inst of Mech Engrs—April 15, 1910. No. 13726 N.

The Cutting Properties of Tool Steel. Edward G. Herbert. Read before the Ir. & St. Inst. Illustrated description of a tool-steel testing-machine designed to overcome difficulties in securing a uniform material, explaining its use and giving results. 2500 w. Engr, Lond—May 6, 1910. Serial. 1st part. No. 13985 A.

MEASUREMENT.

Cooling Curves.

Methods of Obtaining Cooling Curves. Deals with the various methods of taking cooling curves, and their interpretation and values. 3000 w. Engng—May 6, 1910. No. 13974 A.

Gauges.

Tolerances and Limit Gauges. George D. Hadun. Explains the meaning of "tolerance" in machine-shop practice, and the use of limit gauges. 2000 w. Mech Wld—May 13, 1910. No. 14192 A.

Accurate Gage Work in the Bench Lathe. A. L. Monrad. Illustrated description of a simplified method for exact duplication. 3000 w. Mach, N Y—May, 1910. No. 13650 C.

Pyrometry.

A New Pyrometer. Charles E. Foster. Describes a new type of radiation pyrometer and its use. 2200 w. Jour Fr Inst—May, 1910. No. 14295 D.

Steam Meters.

Steam and Air Flow Meters. Illustrates and describes recording and indicating instruments developed by the General Electric Co. 1500 w. Ir Age—May 26, 1910. No. 14385.

Thermometry.

High-Temperature Gas Thermometry and Its Present Limitations. Arthur L. Day. Reviews some of the recent work done to increase the range and accuracy of the temperature scale upon which the various devices for measuring high temperatures depend. 4000 w. Met & Chem Engng—May, 1910. No. 13605 C.

POWER AND TRANSMISSION.

Air Compressors.

Horizontal Compound Air Compressor. Illustrated detailed description. 1000 w. Engr, Lond—April 22, 1910. No. 13735 A.

Accidents to the Delivery Valve in Slide-Valve Compressors (Das Verhalten der Schieberkompressoren bei einer Beschädigung des Druckventils). R. Lorenz. Mathematical discussion of the thermodynamic effects, which have caused serious accidents. Ills. 3000 w. Glückauf—April 23, 1910. No. 14029 D.

Belting.

Transmission of Power by Belts. Reginald Krall. Abstract of a paper read before the Junior Inst. of Engrs. Discusses the use in Europe of steel bands for belts. Also describes the Lenix system in which an idler automatically increases the arc of contact of the belt with the load. 2200 w. Power—May 3, 1910. No. 13670.

CO_2 Engine.

Carroll's Carbonic Acid Engine. An exposé of John E. Carroll's CO_2 engine. Ills. 1500 w. Power—May 24, 1910. No. 14265.

Costs.

See Textile Mills, under POWER AND TRANSMISSION.

Electric Driving.

Motor Application to Machine Tools. Charles Fair. Considers the fundamental principles underlying motor applications to machine tools. Ills. 4000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14345 F.

The Choice of Electric Motors for Intermittent Working (Ueber die Wahl von Elektromotoren für intermittierenden Betrieb). Herr von der Burchard. Discusses the choice of motors for rolling-mill operation. Ills. 2500 w. Stahl u Eisen—April 13, 1910. No. 14055 D.

The Electrical Driving of Textile Machinery. W. B. Woodhouse. An illustrated article giving comparative results with mechanical and electrical driving. 3500 w. Cassier's Mag—May, 1910. No. 13948 B.

Electric Driving of Reversible Roll Trains on the Ilgner System (Commande électrique des Trains de Laminoirs réversibles par la Méthode Ilgner). Describes the system and gives results of its operation. Ills. Serial. 1st part. Rev Indus—April 23, 1910. No. 14023 D.

See also Planers, under MACHINE WORKS AND FOUNDRIES.

Gas Transmission.

Long-Distance Gas Transmission. Harrison Dexter Emerson. Outlines the development and present state of the art of gas transmission, giving information in regard to high-pressure gas pumping in Pennsylvania. Ills. 1400 w. Cassier's Mag—May, 1910. No. 13947 B.

Gearing.

See Electric Hoisting, under MINING AND METALLURGY, MINING.

Lubrication.

Lubrication and Lubricants. Discussion of Dr. C. F. Mabery's paper, by Dr. P. H. Conradsen, and others. Ills. 12800 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14336 F.

Some Recent Lubricators (Quelques Graisseurs nouveaux). Describes recently invented oil-testing and lubricating devices. Ills. 5000 w. Rev de Mécan—April, 1910. No. 14049 E + F.

Mechanical Plants.

La Salle Hotel Power Plant, Chicago. Osborn Monnett. Illustrates and describes the mechanical plant for furnishing heat, light and power. 2500 w. Power—May 17, 1910. No. 13939.

Power Plants.

Government Plant at Washington. F. L. Johnson. Illustrated description of the central power, lighting and heating station, for the United States Capitol, serving a group of buildings. 2000 w. Power—May 10, 1910. No. 13818.

Shaft Bearings.

Ball-Bearing Lineshaft Hangers. Henry Hess. Illustrated description of improved hangers, explaining their advantages. 2000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14333 F.

Shafting.

Effect of Keyways on the Strength of Shafting. James C. Lund. A report of tests, with conclusions. Ills. 1200 w. Technograph, No. 24—1909-10. No. 14372 N.

Textile Mills.

Choice of Power for Textile Mills. Abstract of a paper by Charles T. Main, discussing the cost of steam, hydroelectric, and purchased power for an electrically driven mill. 2000 w. Eng Rec—May 7, 1910. No. 13797.

Tidal Power.

Tidal Power. W. O. Horsnaill. Considers whether there is a possibility of generating power on a large scale by use of the tides. 2000 w. Engr, Lond—May 6, 1910. No. 13981 A.

Turbo-Compressors.

See Centrifugal Pumps, under HYDRAULIC MACHINERY.

STEAM ENGINEERING.

Boiler Capacity.

Increasing Capacity of Steam Boilers. Henry Kreisinger and Walter T. Ray. Investigates the practicability of doubling the grate area and increasing the velocity of the gases without increasing the floor space. 4000 w. Power—May 24, 1910. No. 14264.

The "Le Dalmar" Boiler Cleaner (Le Ramoneur à Air chaud "le Dalmar"). M. Brull. Describes a device for blowing incrustations of soot from the outside or inside of boiler tubes. Ills. 1400 w. Bul Soc d'Encour—March, 1910. No. 14007 G.

Boiler Design.

The Layout of an Arched Smoke Box. Drawings and description of method. 1800 w. Boiler Maker—May, 1910. No. 13921.

Boiler Firing.

Kermode's Liquid-Fuel Apparatus for Water-Tube Boilers. Illustrated description of an installation at Liverpool and an account of the arrangement. Other plants are briefly described. 2000 w. Engng—April 22, 1910. No. 13730 A.

Boiler Fittings.

Water Gauges for Boilers: Some Practical Notes. Points relating to their construction and care are discussed. 2000 w. Prac Engr—May 6, 1910. No. 13969 A.

Boiler Plates.

Tests of Old Boiler Plates. A. H. Eldredge. Reports tests made from test pieces cut from the bottom sheets of fire tube boilers which had been in continuous service for periods ranging from 13 to 22 years, to get information as to the safe age at which a boiler can be used. 1000 w. Sib Jour of Engng—May, 1910. No. 14317 C.

Boiler Repairs.

Applying Patches to Boilers. H. S. Jeffrey. Illustrates and describes the most approved methods. 1500 w. Power—May 24, 1910. No. 14263.

Boiler Scale.

Scale in Boilers and Its Removal. From an article published by the Fidelity & Casualty Co. Deals with causes and dangers of scale, and methods of prevention and removal. 3000 w. Power—May 17, 1910. No. 13941.

The Influence of Scale on Boiler Economy and Safety (Der Einfluss des Kesselsteines auf Wirtschaftlichkeit und Betriebsicherheit von Heizvorrichtungen). E. Reutlinger. Reports a series of tests of heat transmission through scale-covered plates. Ills. Serial. 1st part. 7500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14233 D.

Boiler Waters.

Water Softening. Illustrates and describes a number of systems of softening boiler feed water. 5000 w. Ry Mas Mech—May, 1910. No. 13872.

Engines.

Economy and Design of Modern Reversing Rolling Mill Steam Engines. Eduard G. Sehmer and Dr. R. Drawe. Read before the Ir. & St. Inst. States the requirements of a good steam reversing mill engine, and the means by which these requirements can be fulfilled. Describes a new single lever gear. 3300 w. Mech Engr—May 6, 1910. No. 13971 A.

Tangye's Museum of the Watt Epoch-Making Developments. I. W. Chubb. Illustrated description of interesting drawings, appliances and inventions. 4500 w. Am Mach—Vol. 33. No. 18. No. 13763.

Fuels.

The Combustion of Coal. Joseph A. Holmes. Describes experiments made to ascertain the relation between the amount of volatile combustible driven off and the combustion spaces necessary to burn it completely. Ills. 3000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14344 F.

Thermochemistry of Anthracite. Discusses the principles underlying the calculation of heating values of fuels. 2500 w. Mines & Min—May, 1910. No. 13681 C.

Notes on Various Solid Fuels. Considers fuels, other than ordinary coal, in use. 1200 w. Prac Engr—April 22, 1910. Serial. 1st part. No. 13716 A.

Tests of Washed Grades of Illinois Coal. C. S. McGovney. Describes tests made to facilitate comparisons of various grades. Ills. 28600 w. Univ of Ill Bul, No. 39—Aug. 23, 1909. No. 14268 N.

Transportation and Handling of Steam Coal. Reviews a report of the committee on fuel supply of the Boston Chamber of Commerce. A study of the quality of steam coals and the method of transportation. Relates especially to New England. Maps. 3000 w. Ry Age Gaz—May 13, 1910. No. 13898.

The Utilization of Low-Grade Coal in the Dortmund District (Ausnutzung minderwertiger Brennstoffe auf Zechen des Oberbergamtsbezirks Dortmund). Herrn Bütow and Dobbelstein. Report of a Commission, giving results of tests of inferior grades of fuel in various boiler plants. Ills. Serial. 1st part. 2000 w. Glückauf—April 9, 1910. No. 14075 D.

Heat Transmission.

A Study in Heat Transmission. J. K. Clement and C. M. Garland. Experimental study of the transmission of heat to water in tubes as affected by the velocity of the water. 3500 w. Univ of Ill Bul, No. 40—Sept. 27, 1909. No. 14199 N.

Indicators.

Non-Stop Indicating Gear. Illustrated description of an apparatus which can be fixed to an engine while running, can be started, stopped or removed while the engine is in motion. 900 w. Engr, Lond —April 22, 1910. No. 13738 A.

Safety Valves.

Recent Developments in High-Lift Safety Valves (Neuerungen an Hochhub-Sicherheitsventilen mit vollem Kegelhub). P. H. Rosenkranz. Describes a number of types. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 9, 1910. No. 14235 D.

Stacks.

The Stability of Chimneys. E. W. Beardsley. Gives graphic methods for determining the center of area and stability, approximate rules for proportions and taper and notes on the design of chimney foundations. 2500 w. Power—May 3, 1910. No. 13669.

Steam Properties.

Equivalent Evaporation from and at 212°. F. R. Low. An extension of the Marks-Davis tables on factors of evaporation to include feed water above 212 degrees, and to include modern high pressures. 2 pages of tables. 1200 w. Power—May 10, 1910. No. 13820.

Superheating.

A New Characteristic Equation of Superheated Steam. P. F. Popp. An explanation of the new simplified equation. 900 w. Technograph. No. 24—1909-10. No. 14375 N.

Marine Superheating. Notes based on an inspection of the plant in the Schwann vessel. Ills. 1600 w. Engr, Lond—April 22, 1910. No. 13733 A.

Cast-Iron Fittings for Superheated Steam. Discussion of papers by Prof. Ira N. Hollis, Prof. Edward F. Miller and Arthur S. Mann. Ills. 10700 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14337 F.

Turbine Blades.

The Erosion of Turbine Blades. K. J. Ekblaw. Reports a series of tests upon two Kerr turbine blades to ascertain the wear increase with increase in velocity of steam. 1200 w. Technograph, No. 24 —1909-10. No. 14369 N.

Turbine Design.

The Condition and Action of Steam in Turbines. Ernst J. Berg. Shows the practical considerations that enter into the design of the Curtis turbines. 4500 w. Technograph, No. 24—1909-10. No. 14368 N.

Turbine Economy.

Reducing the Fuel Consumption in Existing Electric Generating Stations. Gives calculations showing the possibilities of the low-pressure turbine in reducing the fuel bill. 1800 w. Engr, Lond—April 29, 1910. No. 13859 A.

Turbine Efficiency.

Energy Losses in Steam-Turbine Buckets. Abstract of an article by Dr. Nikolai Briling in *Zeit. des Ver. Deut Ing.*, describing a series of experiments made to determine the least loss of energy in the buckets of an impulse steam-turbine. Ills. 700 w. Engng—April 29, 1910. No. 13854 A.

Turbine Governing.

Regulation of Mixed Flow Turbines. L. Battu. Explains where mixed-flow turbines are necessary, and considers the methods of regulation. Ills. 3300 w. Power—May 10, 1910. No. 13819.

The Kinematics of Reversing with Indirect Governors (Zur Kinematik der Rückführung bei indirekten Regulatoren). Herr Kröner. Mathematical discussion of two systems of governing. Ills. 2500 w. Die Turbine—April 20, 1910. No. 14093 D.

Turbine Plants.

The Steam-Turbine Plant at the Gouley Mine in the Eschweil District (Die Dampfturbinenanlage auf Grube Gouley des Eschweiler Bergwerksvereins). L. Haas. Detailed description of a generating station serving a group of mines. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1910. No. 14095 D.

The 1,650-Kilowatt Exhaust-Steam Turbo-Generator Plant of the "Fröhliche Morgensonne" Company at Wattenscheid (Die 1650-KW-Abdampfturbogeneratoranlage auf der Gewerkschaft "Fröhliche Morgensonne" zu Wattenscheid). Illustrated description. 3000 w. Elek Kraft u Bahnen—April 23, 1910. No. 14224 D.

Turbines.

The Gutehoffnungshütte Steam Turbine (Die Gutehoffnungshütte-Dampfturbine). Herr Banner. Describes its design, development and present types. Ills. Serial. 1st part. 2200 w. Die Turbine—April 20, 1910. No. 14002 D.

See also Locomotives, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

TRANSPORTING AND CONVEYING.

Cableways.

Aerial Ropeway at Abertillery, South Wales. Illustrated description of a ropeway built on the sectional system, for a colliery. 1200 w. Engng—April 22, 1910. No. 13720 A.

Coal Handling.

Darley Suction Conveyor for Coal and Ashes. Illustrates and describes the installation for the Boston elevated railway. 1000 w. Ir Age—May 12, 1910. No. 13860.

Coal and Coke Handling at the Moosach Gas Works, Munich (Die Kohlen- und Kokstransportanlage des Gaswerkes der Stadt München in Moosach). H. Hermanns. Describes an extensive mechanical plant. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 23, 1910. No. 14240 D.

See also Piers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

The Mechanical Handling of Small Materials. George Frederick Zimmer. Methods and mechanisms for handling fine substances are illustrated and described. 3000 w. Cassier's Mag—May, 1910. No. 13951 B.

Mechanical Transport in the Foundry (Der mechanische Massentransport in der Giesserei). Hubert Hermanns. Describes conveyors, aerial tramways, elevators, etc., applicable to foundry work. Ills. Serial. 1st part. 1500 w. Stahl u Eisen—April 6, 1910. No. 14052 D.

Cranes.

The Design of Crane Trusses (Zur Berechnung von Kranträgern). H. Müller. Mathematical. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14244 D.

Freight Handling.

Trans-shipment of Building Materials on the Berlin Waterways and the Application of Mechanical Devices to the Handling of Brick (Der Umschlagverkehr in Baumaterialien auf den Berliner Wasserstrassen und die zweckmässigkeit der Verwendung mechanischer Entladevorrichtungen für den Ziegeltransport). Carl Claus. Ills. 4000 w. Tech u Wirt—April, 1910. No. 14247 D.

Ore Handling.

The Sieurin Ore Discharging Gear. Illustrated description of the apparatus and its operation. 2000 w. Marine Rev—May, 1910. No. 14104.

MISCELLANY.

Aeronautics.

The Problem of Flight (Betrachtungen über das Flugproblem). L. Prandtl. A general discussion of aeroplane design. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14241 D.

A Graphical Method of Designing Aerial Propellers and Its Special Application to the Calculation of the Strength of the Propeller. Comparison of the Calculation with the Practical Result (Methode für die graphische Berechnung einer Luftschraube und ihre spezielle Verwendung für die Festigkeitsberechnung der Schraube. Vergleich der Rechnung mit der Wirklichkeit). C. Eberhardt. Mathematical. Ills. Serial. 1st part. 3000 w. Motorwagen—April 20, 1910. No. 14099 D.

Recent Progress in Aviation. Octave Chanute. An illustrated review of recent work with flying machines, and interesting information related to the subject. Also a chronology of aviation. 8000 w. Jour W Soc of Engrs—April, 1910. No. 14325 D.

The Flight from London to Manchester. The aviators' own accounts, with illustrations. 1200 w. Sci Am—May 14, 1910. No. 13885.

Trans-Oceanic Aviation. Editorial discussion of the plan recently proposed to cross the Atlantic in an airship. 1200 w. Engng—May 13, 1910. No. 14196 A.

Dirigibles and Aeroplanes in War (I Dirigibili ed i Velivoli come Ordegn di Guerra e come Bersagl). Discusses balloons and aeroplanes as instruments of attack and methods of defense against them. Ills. 10000 w. Riv Marit—April, 1910. No. 14035 E + F.

Table of Aeroplanes at Olympia. Gives table of particulars of each machine, with observations on the theories of flight. 4000 w. Sci Am Sup—May 7, 1910. No. 13786.

A Pioneer French Aeroplane That Has Made Many Flights. Augustus Post. Illustrated description of a monoplane type of good workmanship, which has an ingenious motor. 2500 w. Am Mach—Vol. 33. No. 20. No. 14117.

Guns.

Chats on Artillery (Causeries sur l'Artillerie). Colonel Vallier. The first part discusses guns for attacking balloons and aeroplanes. Ills. Serial. 1st part. 2300 w. Tech Mod—April, 1910. No. 14015 D.

Tabulating Machines.

Handling the Census Returns for the Whole United States. Illustrates and describes the machines which make and count the cards and tabulate the records. 2000 w. Am Mach—Vol. 33. No. 18. No. 13759.

Textile Industry.

The Mechanical Engineer and the Textile Industry. H. L. Gautt. Describes an automatic piling machine and a new arrangement of bleachery, in proof of the usefulness of the mechanical engineer in this field. Ills. 600 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14332 F.

MINING AND METALLURGY.

COAL AND COKE.

Blasting.

Utah Fuel Co.'s Shot-Firing Rules. A. C. Watts. Regulations for the storage and handling of explosives, loading holes and firing shots enforced by this company. 2400 w. Mines & Min—May, 1910. No. 13676 C.

The Hydraulic Mining Cartridge. Henry M. Payne. Illustrated description of an appliance for mining coal without the use of explosives. 1500 w. Mines & Min—May, 1910. No. 13674 C.

Colorado.

Coal Fields of Southern Colorado. Describes the geological conditions and their influence on the mining methods employed. 2000 w. Mines & Min—May, 1910. No. 13675 C.

See also Mining, under Coal and Coke.

Electric Power.

Electricity in Mining. J. Glynn Williams. Discusses proper equipment, operation, some causes of accidents, etc. 3000 w. Elec Rev, Lond—April 22, 1910. No. 13709 A.

The Installation and Management of Electrical Plant in Coal Mines. T. Campbell Futers. Considers applications that may be made from the first step of opening a new coalfield, the questions to be decided in selecting plant, etc. 2500 w. Elec Rev, Lond—April 22, 1910. No. 13710 A.

Electric Cable Systems in Collieries. Editorial review of the discussion before the Institution of Electrical Engineers, following the reading of W. Wellesley Wood's paper dealing with this subject. 2800 w. Engng—May 13, 1910. No. 14195 A.

Automatic Protective Switchgear for Colliery Service. E. B. Wedmore. Abstract of paper read at Midland Inst. of Min., Civ. & Mech. Engrs. Discusses the arrangement of trip coils and the action of automatic leakage devices in mines. 1600 w. Elect'n, Lond—May 6, 1910. No. 13967 A.

Storage Batteries in Colliery Work. J. Glynn Williams. Discusses the economical advantages. Short discussion. 4500 w. Ir & Coal Trds Rev—May 6, 1910. No. 14101 A.

Earthed v. Insulated Neutrals in Colliery Installations. W. Wellesley Wood. Read before the Inst. of Elec. Engrs., Newcastle Sec. Discusses the advantages and disadvantages of working in a three-phase colliery installation with an earthed as against an unearthed neutral. 2500 w. Elec Engr, Lond—April 29, 1910. No. 13841 A.

See also Isolated Plants, and Switchgear, under ELECTRICAL ENGINEERING, Generating Stations.

Explosions.

Catastrophes in American Mines. Messrs. Taffanel and Dunaime. A resumé of the report of the French Committee of Mines on the Monongah, Darr and Naomi accidents. 4000 w. Mines & Min—May, 1910. No. 13677 C.

Darran Colliery Explosion. Report of the circumstances attending an explosion of coal dust in South Wales. 4000 w. Col Guard—April 22, 1910. No. 13725 A.

Gas Explosions in Belgium (Grubengasausbrüche in Belgien). Herr Bracht. A review of notable explosions and preventive methods employed. Ills. 9500 w. Glückauf—April 2, 1910. No. 14072 D.

Catalytic Action and Explosions of Gas (Katalytische Wirkungen und Schlagwetterexplosionen). Hans Fleissner. Offers an explanation of the causes of gas explosions. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—April 9, 1910. 14068 D.

Explosives.

Permissible Explosives Used in Coal Mines. J. J. Rutledge. Information concerning the permissible explosives used in the United States, and their advantages. 1500 w. Technograph, No. 24—1909-10. No. 14370 N.

Mine Air.

Moisture in Mine Air. Considers the hygienic and mechanical effects of moisture, how a mine dries out and methods of avoiding it. 4500 w. Mines & Min—May, 1910. No. 13673 C.

Mine Gas.

Firedamp; Its Composition, Detection and Estimation. Dr. Thomas Gray. Abstract of a paper read before the Min. Inst. of Scotland. Gives a summary of researches, and considers methods of testing for gas. 2000 w. Ir & Coal Trds Rev—April 22, 1910. No. 13744 A.

Mine Maps.

Mapping Methods in Pittsburg Field. J. H. Dickerson. Gives the scale used, the different colors, and the methods of indicating different objects and workings. 2000 w. Mines & Min—May, 1910. No. 13680 C.

Mine Shops.

See Shop Design, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Mining.

Report on Coal Mines Regulations Relating to Submarine Coal Areas. T. E. Forster. Report submitted to the government of Nova Scotia. 2500 w. Can Min Jour—May 1, 1910. No. 13685.

A Suggestion to the Coal Mining Industry. T. B. Bancroft. Thinks if entries were driven first to the boundary and the retreating system used, there would be greater recovery and fewer fatalities. 3300 w. Eng & Min Jour—April 30, 1910. No. 13636.

Coal Mining at Primero, Colorado. R. L. Herrick. Describes different methods that have been adapted to fit the conditions. Plan. 1800 w. Mines & Min—May, 1910. No. 13678 C.

Mining by Successive Slices (Le Stossbau). L. Crussard. An exhaustive description of the diverse forms and applications of this method of mining. Serial. 1st part. 4500 w. Tech Mod—April, 1910. No. 14014 D.

Rescue Appliances.

Tissot Breathing Apparatus for Rescue Work. Henry Briggs. Describes the machine and gives instructions for its use. Ills. 2500 w. Eng & Min Jour—May 14, 1910. No. 13928.

Rescue Stations.

Rescue Station at Leiseuring No. 1. Charles B. Franks. Abstract of a paper read before the Coal Min. Inst. of America, at Pittsburg. Describes the general safety measures of the H. C. Frick Coke Co. 2000 w. Mines & Min—May, 1910. No. 13679 C.

Safety Lamps.

Lamp Cabin at the Tinsley Park Collieries. Plan and illustrated description of a cabin for safety lamps and their care. 1000 w. Ir & Coal Trds Rev—May 13, 1910. No. 14261 A.

Supplies.

The Known Coal Deposits of the Earth and the Time of Their Probable Exhaustion (Die bekannten Steinkohlenlager der Erde und der Zeitpunkt ihrer voraussichtlichen Erschöpfung). Fritz Frech. An exhaustive study, beginning with England and Germany. Serial. 1st part. 8000 w. Glückauf—April 30, 1910. No. 14080 D.

COPPER.

Alaska.

The Copper-Bearing Amygdaloids of the White River Region, Alaska. Adolph Knopf. Describes the geological features and modes of occurrence, discussing the origin. 3000 w. Ec-Geol—April, 1910. No. 14314 D.

British Columbia.

The True Fissure and Broadview Mines, B. C. Newton W. Emmens. Illustrated description of these mines of low-grade ore and the methods used. 2500 w. Min Wld—May 7, 1910. No. 13802.

Converters.

The Vortex Copper Converter. Herbert Haas. Discusses the consumption of air in converters, the arrangement of tuyeres, etc. 2200 w. Eng & Min Jour—May 7, 1910. No. 13795.

Oklahoma.

Copper in the "Red Beds" of Oklahoma. William Arthur Tarr. Notes on the occurrence of this deposit, of probably Permian age. Contains also high values of gold and silver. Ills. 1500 w. Ec-Geol—April, 1910. No. 14312 D.

Portugal.

See Spain, under COPPER.

Review of 1909.

Copper Production and Price in 1909 and the Present Outlook. John B. C. Kershaw. A study of the statistics for 1909. 1000 w. Elec Rev, Lond—May 13, 1910. No. 14183 A.

Smelting.

Recent Reverberatory Smelting Practice. Redick R. Moore. Notes on means of overcoming difficulties encountered, with suggestions for improvements. 4500 w. Eng & Min Jour—May 14, 1910. Serial. 1st part. No. 13926.

Reverbatory Treatment of Copper and Copper Mattes. H. Schroder. Describes the method adopted at the Great Cobar, Ltd., Lithgow Works (N. S. W.) 2000 w. Aust Min Stand—April 6, 1910. No. 13838 B.

Spain.

The Copper Mines of Southern Spain and Portugal. The present number describes the situation, general features and trade. Map. 1600 w. Min Jour—April 30, 1910. Serial. 1st part. No. 13851 A.

Utah.

Underground Mining Practice at Bingham, Utah. Leroy A. Palmer. Illustrated description of the methods at the various copper mines of this district. 7500 w. Min Wld—April 30, 1910. No. 13642.

GOLD AND SILVER.

Amalgamation.

Principles of Electrolytic Amalgamation. Elmer E. Carey. Discusses the underlying principles of amalgamation. 2000 w. Min Wld—April 30, 1910. No. 13644.

Recovery of Values in Dredge and Placer Tailings. Elmer Ellsworth Carey. Calls attention to the amount of gold lost in dredging and indicates a method of saving by the use of electro-chemical mercury riffles. 1500 w. Min Jour—April 23, 1910. No. 13717 A.

Bohemia.

The Mt. Roudny Gold Deposit. Joseph T. Singewald, Jr. Describes recent operations on a long abandoned gold occurrence in Bohemia. 2000 w. Ec-Geol—April, 1910. No. 14315 D.

Bolivia.

Gold Dredging Possibilities in Bolivia.

Alexander Benson. Brief account of rich unexplored fields in the interior, and the difficulties that must be overcome in their development. 1800 w. Min Wld—April 30, 1910. No. 13643.

Chlorination.

Chlorination Process at the Kennedy Mine, Cal. W. H. Storms. Describes the treatment of auriferous sulphides. 1600 w. Min Wld—May 7, 1910. No. 13804.

Cobalt.

The McKinley-Darragh-Savage Mines of Cobalt, Limited. Abstract of General Manager P. A. Robbins' report for the year 1909. 3500 w. Can Min Jour—May 15, 1910. Serial. 1st part. No. 14113.

Cyaniding.

Some Characteristics of Sands in Cyaniding. Herbert A. Megraw. Gives results of experiments with a particular kind of ore. 1500 w. Min Wld—May 7 1910. No. 13801.

Improvement in Cyanide Practice. E. Gybbon Spilsbury. Describes a mechanical improvement by which agitation of the solution by air passed through silica sponge causes rapid action of the cyanide. Reports tests made with this porous diaphragm. Ills. 3000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14342 F.

Dredging.

Cost of Dredging in Russia and Siberia. W. H. Shockley. Information based on a report of the Commission of Engineers organized to consider the utility of dredges in Russia. 1500 w. Min & Sci Pr—May 7, 1910. No. 13880.

See also Bolivia, under Gold and Silver; and Dredges, under MARINE AND NAVAL ENGINEERING.

Madagascar.

The New Gold Mines in Northern Madagascar (Les Nouvelles Mines d'Or du Nord de Madagascar). Albert Bordeaux. A description of the deposits and their exploitation. Ills. 4000 w. Génie Civil—April 30, 1910. No. 14032 D.

Mexico.

Old Mining Camp of Pozos, Guanajuato, Mex. H. A. Magraw. Outlines the history of this camp where the patio process is being replaced by cyanidation. Ills. 1800 w. Eng & Min Jour—May 7, 1910. No. 13792.

Nevada.

Jarbridge, Nevada. W. A. Scott. An illustrated account of the country, properties, and ores and results of sampling for gold and silver. 2000 w. Min & Sci Pr—April 30, 1910. No. 13768.

New Mexico.

The Black Range Mining District, New Mexico. Martin Fishback. An account of deposits of both high and low grade ores, yielding both gold and silver. 1200 w. Eng & Min Jour—April 30, 1910. No. 13632.

Ontario.

A Brief Description of the Gow Ganda Silver District in Ontario, Canada. Percy R. Iseman. Brief account of the topography, geology, and economic conditions. Ills. 1000 w. Sch of Mines Qr—Jan., 1910. No. 14302 D.

Rand.

New Policy Adopted in Rand Mining Operations. Owen Letcher. Discusses the substitution of a square fathom stoped for the old unit of a ton milled. 2500 w. Min Wld—May 14, 1910. No. 13932.

Further Notes on Rand Mining. Tom Johnson. Notes on troubles with the roof of working places. Ills. 4400 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1910. No. 13702 E.

Sumatra.

Mining at the Redjang-Lebong Gold-Silver Mine, Sumatra. H. Philp. Information in regard to the old workings, geology, ore bodies, methods, and labor conditions. 2500 w. Jour Chem, Met, & Min Soc of S Africa—March, 1910. No. 13957 E.

IRON AND STEEL.

Analysis.

The Determination of Carbon in Pig and Cast Iron (Kohlenstoffbestimmung im Roh- und Gusseisen). J. Treuheit. Describes a new apparatus for rapid determinations. Ills. 1800 w. Giesserei-Zeit—April 1, 1910. No. 14062 D.

Armor Plate.

The Fabrication of Armor Plate by the Krupp Process (Fabrication des Plaques de Blindage par le Procédé "Krupp"). Ugo F. Gregoretti. A detailed description of the process, translated from *Rivista Marittima*. Ills. 5500 w. Rev de Métal—April, 1910. No. 14005 E + F.

Blast-Furnace Gas.

See Gas Engines, under MECHANICAL ENGINEERING, Combustion Motors.

Blast-Furnace Practice.

Recent Developments in the Metallurgy of Iron. B. Neumann. A résumé of the improvements and experiments, covering furnace practice and construction. 3500 w. Eng & Min Jour—May 21, 1910. No. 14144.

Anthracite Iron Smelting in South Wales. A summary of particulars recently collected by E. Roberts. 1500 w. Ir & Coal Trds Rev—May 13, 1910. No. 14200 A.

Causes of Non-Uniformity of Blast Furnace Operation. Edward B. Cook. Discusses Prof. J. W. Richards' articles on blast furnace practice and the chief difficulty. 3500 w. Met & Chem Engng—May, 1910. No. 13903 C.

Blast Furnaces.

The New Blast Furnace of the Bethlehem Steel Company. W. S. Landis. Illustrated detailed description. 1000 w. Met & Chem Engng—May, 1910. Serial. 1st part. No. 13687 C.

New Hematite Blast Furnace at Consett. Illustrated description. 1200 w. Ir & Coal Trds Rev—May 6, 1910. No. 13998 A.

New Blast Furnace Plant of the Gutehoffnungshütte. Elevation, detail sections and descriptions of this new plant. 1200 w. Ir & Coal Trds Rev—April 29, 1910. No. 13867 A.

Blowing Engines.

Recent Blowing Engines with Disc Valves (Neuere Gebläsemaschinen mit selbsttätigen Plattenvertilen). Herr Schwanecke. Describes recent Borsig machines. Ills. 2000 w. Stahl u Eisen—April 13, 1910. No. 14056 D.

British Empire.

Iron and Steel Industry of the British Empire. Gives statistics concerning the value of imports and exports, and other features of this industry. 1200 w. Ir & Coal Trds Rev—April 22, 1910. No. 13743 A.

Electrometallurgy.

Electric Furnaces of the Induction Type. T. Rowlands. Read before the Am. Elec.-Chem. Soc. Reviews the progress with the Kjellin furnace and the Röchling-Rodenhauser modification used for large tonnages. 4000 w. Ir Age—May 12, 1910. No. 13870.

An Electric Smelting Furnace. Edward R. Taylor. Illustrated description of the author's design for reducing iron ore. 2200 w. Ir Age—May 19, 1910. No. 14111.

The Girod Furnace. W. Borchers. Read before the Ir. & St. Inst. Illustrated description of an electric furnace for steel-making, explaining the principles. 3000 w. Elec Engr, Lond—May 6, 1910. No. 13960 A.

The Production and Refining of Steel in the Electric Furnace (Produzione e Affinazione dell' Acciaio al Forno elettrico). Remo Cantani. Reviews progress in the electrometallurgy of steel and discusses its technical and economic possibilities. 8000 w. Riv Marit—April, 1910. No. 14034 E + F.

The Alleged Inequality of the Charge in Electric Induction Steel Furnaces (Ueber die angebliche Ungleichmässigkeit der Chargen in Elektrostahlöfen mit Induktionsheizung). V. Engelhardt. Discusses the effect of variations in temperature in different parts of induction furnaces. Ills. 2200 w. Stahl u Eisen—April 20, 1910. No. 14059 D.

Germany.

The Lorraine-Luxemburg Mining and Iron Industry (Die Lothringisch—Luxemburgische Montan- und Eisenindustrie). M. Ungeheuer. A general review of mining in the minette district. Ills. 7500 w. Tech u Wirt—April, 1910. No. 14246 D.

Hudson Bay.

An Algonkian Basin in Hudson Bay—A Comparison with the Lake Superior Basin. C. K. Leith. Shows the repetition of essentially Lake Superior conditions in the Hudson Bay territory. No discoveries are yet made to warrant commercial comparison. Map. 6000 w. Ec-Geol—April, 1910. No. 14313 D.

Open Hearth.

The Attainment of Highest Purity Iron on a Commercial Basis. James A. Aupperle. Illustrated description of the process and product known as American ingot iron. 1200 w. Met & Chem Engng—May, 1910. No. 13697 C.

Production.

Some Factors Affecting the Production and Exports of Iron and Steel. Harold Jeans. Read before the S. Staffordshire Ir. & St. Inst. Considers the relation between export and production, and reviews the destination of the exports of the principal countries and some of the factors affecting them. 2500 w. Ir & Coal Trds Rev—April 22, 1910. Serial. 1st part. No. 13741 A.

Rolling Mills.

Development in the Production of Electric Power: Its Application and Bearing Upon the Iron and Steel Industries. D. L. Selby Bigge. Read before the I. and S. Inst. Discusses progress in England during the past three years, explaining new developments which have reduced the cost of production, especially discussing the possibilities in iron and steel works. Ills. 9000 w. Ir & Coal Trds Rev—May 6, 1910. No. 13989 A.

An Electrically Operated Reversing Blooming Mill. Illustrated description of a recent German plant. 4000 w. Elec Rev, N Y—May 14, 1910. No. 13929.

A Continuous Billet Mill. Illustrates and describes an important addition to the Cambria Steel Co.'s plant at Johnstown, Pa. 2000 w. Ir Age—May 5, 1910. No. 13748.

The New 18-Inch Billet Mill of the Cambria Steel Co. Illustrated description of the Continuous process of rolling billets and ton bar, at Johnstown, Pa. 2500 w. Ir Trd Rev—May 12, 1910. No. 13878.

The Employment of Continuous Roll Trains in German Steel Works (Ueber die Verwendung kontinuierlicher Walzenstrassen auf deutschen Hüttenwerken). F. Schruff. A detailed description of German practice. Ills. 5500 w. Stahl u Eisen—April 13, 1910. No. 14054 D.

See also Engines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Smelting.

Native Iron Smelting in Haute Guinee

(West Africa). J. Morrow Campbell. Read before the Inst. of Min. & Met. Brief description of native iron furnaces, differing from any before recorded. 1500 w. Ir & Coal Trds Rev—April 22, 1910. No. 13740 A.

Steel Making.

Transformetal Process of Changing Iron Into Steel. E. F. Lake. Presents the claims of a process which aims to change all grades of iron into steel. Ills. 2000 w. Am Mach—Vol. 33. No. 19. No. 13876.

Steel Refining.

The Present Status of Steel Refining Processes (Etat actuel du Procéde d'Affinage sur Sole). Otto Petersen. Abstract translation from *Stahl und Eisen.* Discusses the various processes of steel refining in the open-hearth furnace. Ills. 16000 w. Rev de Métal—April, 1910. No. 14002 E + F.

Steel Works.

Power for Modern Steel Works (Die Maschinenanlage auf modernen Hüttenwerken). M. Langer. Discusses the relative merits of steam and gas power, giving preference to the latter. Also number of letters on the same subject. 8500 w. Stahl u Eisen—April 20, 1910. No. 14058 D.

Trade.

Presidential Address before the Iron and Steel Institute. Duke of Devonshire. Reviews the economic conditions which prevailed in the year of the formation of the Institute (1869), and compares them with the present. 5500 w. Ir & Coal Trds Rev—May 6, 1910. No. 13986 A.

LEAD AND ZINC.

Mexico.

The Real de Xichu Mining District, Mexico. Claud Hafer. Brief historical review with description of the principal mining operations now being carried on. The ores are argentiferous galena, pyrite and zinc-blende. Ills. 1800 w. Min Wld—May 21, 1910. No. 14160.

The Cabrillas Lead Mines of Coahuila, Mexico. S. J. Lewis. Gives the early history, geological features, origin and character of the ore, mining methods, etc. Ills. 2500 w. Eng & Min Jour—May 21, 1910. No. 14145.

Missouri.

Developing a New Ore Horizon. Lucius L. Wittich. Concerning the large bodies of zinc ore lying at levels beneath those already developed, at Joplin, Mo. Ills. 3500 w. Mines & Min—May, 1910. No. 13684 C.

Zinc Smelting.

Recent Advances in the Electrometallurgy of Zinc. Franz Peters. Abridged translation from *Glückauf.* Considers smelting processes. Ills. 2500 w. Eng & Min Jour—May 14, 1910. No. 13925.

MINOR MINERALS.

Asbestos.

The Quarries of the Canadian Asbestos District. Fritz Cirkel. Illustrated description of the occurrence, quarries, and mills, production and uses. 1500 w. Eng & Min Jour—April 30, 1910. No. 13634.

Clays.

The West of England China Clay and Stone Company, Limited, St. Austell. Describes the development of a china clay and china stone quarry, explaining how their products are utilized for commercial purposes. Ills. 3000 w. Quarry—May, 1910. No. 13843 A.

Diamonds.

Diamond Mining. Henry Leffman. Brief account of the methods of mining and matters related. Ills. 1500 w. Pro Engrs' Club of Phila—April, 1910. No. 14269 D.

Nickel.

The Nickel-Copper Industry of Ontario. Alex. Gray. Map, and review of discoveries, companies organized, etc. 6500 w. Min Wld—May 14, 1910. Serial. 1st part. No. 13931.

Electric Smelting of Nickel Ore. Illustrated description of a new electric furnace plant for nickel silicide in North Carolina. 1200 w. Met & Chem Engng—May, 1910. No. 13701 C.

Oil.

The Petroleum Fields of the United States. W. G. Burroughs. Briefly describes the characteristics of each of the more important fields. 4000 w. Eng & Min Jour—April 30, 1910. No. 13635.

Development of Coalinga Oil Field, California. Paul W. Prutzman. Map and description of the work accomplished and new developments. 2800 w. Min Wld—May 21, 1910. No. 14161.

Petroleum Development in San Joaquin Valley. Information, from a recent report of the State Mining Bureau, concerning this oil district of California. 3000 w. Eng & Min Jour—May 7, 1910. No. 13793.

A Phenomenal Oil Gusher. Charles Carrol Wright. Illustrated description of the largest oil gusher in the history of California. 600 w. Sci Am—May 21, 1910. No. 14128.

A Natural Naphtha from the Province of Santa Clara, Cuba. Clifford Richardson and Kenneth Gerard Mackenzie. Describes a naturally occurring white naphtha. 1800 w. Am Jour of Sci—May, 1910. No. 14206 D.

Platinum.

Russian Platinum and Foreign Companies in Russia. V. X. Pravdinsky. An explanation of the platinum industry and the control of the situation. 2500 w. Eng & Min Jour—May 14, 1910. No. 13927.

Salt.

Leaching Brine from Salt Mines (Soleerzeugung durch Berieselung). C. Schraml. Gives results of this method of salt mining in Austria during 1909. Ills. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—April 23, 1910. No. 14070 D.

The Grubach and Abtenau Salt Deposits (Das Salzgebirge von Grubach und Abtenau). Hans Reinl. Discusses the extent and exploitation of these salt deposits in Austria. Ills. Serial. 1st part. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—April 16, 1910. No. 14069 D.

Sodium.

Metallic Sodium from Fused Sodium Chloride. C. F. Carrier, Jr. An illustrated report of investigations giving promising results. 4000 w. Met & Chem Engng—May, 1910. No. 13694 C.

Sulphur.

Employment of Rock Sulphur for Manufacture of Sulphur Acid. Prof. Giuseppe Odds. Discusses the commercial possibility of utilizing rock sulphur for the manufacture of sulphuric acid. 3000 w. Min Jour—April 30, 1910. Serial. 1st part. No. 13850 A.

Tin.

The Assay of Tin Ores. Jas. Gray. Considers the dry assay and the wet analysis. 2500 w. Jour Chem, Met & Min Soc of S Africa—March, 1910. No. 13956 E.

Glimpses Underground. T. A. Rickard. Amusing sketches of Cornishmen at work underground in the tin mines of England, with explanatory notes. 800 w. Min & Sci Pri—May 14, 1910. No. 14133.

MINING.

Boring.

See Wells, under CIVIL ENGINEERING, WATER SUPPLY.

Diamond Drilling.

Cost of Diamond Drilling in Australia. J. Allan Thompson. Explains some petrographical considerations affecting the wear of diamonds. 1200 w. Aust Min Stand—April 13, 1910. No. 14108 B.

Drills.

Hammer Drills in Overhand Stoping and Raising. H. B. Williams. An account of the writer's experience of their performance. Ills. 1500 w. Inst of Min & Met, Bul. 67—April 14, 1910. No. 14354 N.

Electric Hoisting.

Electric Mine-Hoists. D. B. Rushmore and K. A. Pauly. Presents the advantages of the electric hoist, claiming economy, greater safety, adaptation to underground workings, and the possibility by using water power. 8000 w. Bul Am Inst of Min Engrs—May, 1910. No. 14343 F.

Tests of an Ilgner Electric Hoist. R. R. Seeber. Describes the installation of the Winona Copper Co., reporting test. Diagrams. 2000 w. Pro Am Inst of Elec Engrs—May, 1910. No. 14349 F.

Determining Efficiency of Electric Hoist Gearing. S. H. Libbey. Illustrated discussion of spur gear and worm gear types, showing them to be equally efficient. 2000 w. Am Mach—Vol. 33. No. 21. No. 14387.

Electric Power.

Mechanical Defects in Mining Motors. A statement of troubles found in connection with motors installed in mines. Ills. 2000 w. Elec Rev, Lond—May 6, 1910. No. 13961 A.

Direct-Current Distribution on the Series System for Mines (La Distribution par Courant continu en Série dans les Mines). A discussion of the advantages of this system of power distribution in mining work. Ills. 2700 w. Génie Civil—April 30, 1910. No. 14033 D.

Hoisting.

"Whitmore" Overwinding Gear. H. J. H. King. Read before the Nat. Assn. of Col. Mgrs. Illustrated description of the apparatus and its applications. 2800 w. Ir & Coal Trds Rev—May 6, 1910. No. 13999 A.

See also Axles, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Hoisting Cages.

Safety-Clutch Construction for Cages (Notiz zur konstruktiven Ausbildung der Bewegungsmechanismen für bremsend wirkende Fangvorichtungen). Wzl. Macka. Brief discussion of a number of types. Ills. 1000 w. Oest Zeitschr f Berg- u Hüttenwesen—April 2, 1910. No. 14067 D.

Hoisting Engines.

Acceptance Test of a Steam Hoisting Engine (Abnahmeversuche an einer Dampffördermaschine). Describes and gives results of tests of a hoist on the Koepe system. Ills. 1500 w. Glückauf—April 23, 1910. No. 14078 D.

Law.

Geologic Bases of Mining Law. Courtenay De Kalb. Address before the San Francisco Bar Assn. Explains the variety of ore deposits and their sources, and the mining laws of the present, showing that they were formed when knowledge was too limited to cover all the facts. 6000 w. Min & Sci Pr—May 7, 1910. No. 13882.

Ore Thefts.

The Cause and Prevention of "High-Grading." A. H. Martin. Discusses the troubles from theft of ore. 1700 w. Min Wld—May 7, 1910. No. 13803.

Shaft Lining.

Brier Hill Concrete Lined Shaft, Vulcan, Mich. William Kelly. Abstract of a paper read before the L. Superior Min. Inst. Illustrates and describes the lining of a circular shaft 850 ft. deep and 14 ft. in diameter. 1500 w. Eng & Min Jour—May 7, 1910. No. 13794.

Reinforced-Concrete Shaft and Tunnel Lining (Die zweckmässige Ausbildung des Schacht- und Streckenausbaues in Eisenbeton). Richard Wuczkowski. Mathematical discussion of the design of shaft and tunnel linings. Ills. 7000 w. Glückauf—April 16, 1910. No. 14076 D.

Shaft Sinking.

Electricity in Colliery Sinking Operations. States the principal advantages claimed for electric sinking, and gives illustrated description of the plant at the Hamsterley Collieries. 2000 w. Elec Rev, Lond—May 6, 1910. No. 13962 A.

The New Sinking at Astley, Manchester, Eng. Illustrated description of shafts to be carried to an approximate depth of 950 yards, and 1150 yards respectively. 1200 w. Ir & Coal Trds Rev—April 29, 1910. No. 13868 A.

Sinking Into the Lower Coal Measures in the Hulton Colliery. Abstract of paper by Alfred J. Tonge, and a discussion. Describes the geological features, and gives brief account of the sinking. 3000 w. Ir & Coal Trds Rev—April 22, 1910. No. 13742 A.

Stowing.

An Experiment with a New Method of Stowing (Versuche mit einer neuen Art des Bergeversatzes). Herr Rossenbeck. Discusses a new method employed in German coal mines and its cost. Ills. 3000 w. Glückauf—April 23, 1910. No. 14077 D.

Surveying.

Practical Hints on Underground Surveying. William A. O'Flynn. Suggestions for work in mine surveying. 1500 w. Ap Sci—April, 1910. No. 14284 C.

Ventilation.

Size of Shaft as a Factor in Mine Ventilation (Die relative und normale Grubenweite). Herr Kezel. Mathematical discussion. Ills. 3500 w. Glückauf—April 2, 1910. No. 14073 D.

Examples of Fan Construction (Exemples pris dans le Domaine de la Construction des Ventilateurs). Th. V. Bavier. Describes the various types of fans devised within the last thirty years for mine ventilation. Ills. 3000 w. All Indus—April, 1910. No. 14022 D.

ORE DRESSING AND CONCENTRATION.

Classifiers.

Hydraulic Classification and Flow of Pulp in Launders. A. S. Ostreicher. Illustrates how graphic kinetics can be applied to the computation of diagrams, and gives a study of hydraulic separation. 4000 w. Jour S African Assn of Engrs—March, 1910. No. 13058 F.

Flotation Process.

Oil Flotation Process at Broken Hill, N. S. W. Theodore J. Hoover. Illustrates and describes a plant where zinc and lead sulphides are collected in a froth and floated off; the highest recovery is from slime, and the total cost $1.84 per ton. 2200 w. Eng & Min Jour—April 30, 1910. No. 13633.

Screening.

Clay Screens vs. Drying Ores. H. W. Fox. Illustrated description of an apparatus by which wet ores may be screened without preliminary drying. 1800 w. Mines & Min—May, 1910. No. 13682 C.

Sintering.

Sintering of Fine Ore and a Sintering Machine. Alfales B. Young. Read before the W. Assn. of Tech. Chemists and Metallurgists. Describes the more important processes and gives an illustrated description of apparatus. 2200 w. Met & Chem Engng—May, 1910. No. 13696 C.

Slimes Treatment.

The Elements of Slime Concentration. Walter McDermott. Discusses the recovery of slime material aiming to indicate the most promising directions for improvements. 5800 w. Inst of Min & Met, Bul. 67—April 14, 1910. No. 14352 N.

Stamp Mills.

Limitations of One and Five Stamp Batteries. Algernon Del Mar. Discusses amalgamating results with the single-unit and five-unit stamps, showing that a thorough test is necessary before deciding which to use. 1500 w. Min & Sci Pr—May 7, 1910. No. 13881.

Tailings Disposal.

Handling Tailings at Colorado City. R. L. Herrick. Describes a special form of centrifugal pump and method of distributing tailings. Ills. 3300 w. Mines & Min—May, 1910. No. 13683 C.

Tube Mills.

The Tube-Mill Circuit and Classification. G. O. Smart. Explains how a desirable uniformity of feed can be better secured, than by the classifiers in common use. Ills. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1910. No. 13703 E.

MISCELLANY.

Assaying.

New Analytical Methods. F. H. Mason. A volumetric method for determining sulphates; a new method for detecting caesium, rubidium, and sodium. 1200 w. Min & Sci Pr—May 14, 1910. No. 14134.

Charcoal.

The Manufacture, Properties and Uses of Charcoals. The characteristics of wood, animal, and gas charcoals are considered and the applications in metallurgy and other fields. 1400 w. Prac Engr—May 6, 1910. Serial. 1st part. No. 13070 A.

Hungary.

The Exploitation of Hungarian Ore Deposits (Ungarische Erzlagerstätten, ihre Ausbeutung und die Zugutemachung der Erze). Herrn Arlt and Scheffer. Describes various ore deposits and methods of extraction. Ills. 10000 w. Glückauf—April 9, 1910. No. 14074 D.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Railway Signalling. Prof. V. J. Smart. The present number discusses block signalling, its advantages and weaknesses. 3000 w. Can Engr—May 6, 1910. Serial. 1st part. No. 13817.

Combination Lock and Block and Automatic Signals for Single-Track Sections, Central New England Ry. Illustrated description of system, and explanation of conditions. 3000 w. Ry & Engng Rev—May 14, 1910. No. 13936.

See also Switches, under PERMANENT WAY AND BUILDINGS.

Wages.

A New Principle for Fixing the Wages of Railway Employees. Editorial criticism of the decision rendered by the federal board of arbitration at Chicago, regarding wages to be paid by the railways to members of the Switchmen's Union. 1200 w. Ry Age Gaz—May 20, 1910. No. 14137.

New York Central Wages. Gives the decision of the arbitrators in the case of the N. Y. C. & H. R. conductors and trainmen. 2500 w. Ry Age Gaz—May 13, 1910. No. 13902.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Maintenance. Discusses improper repairs. 1500 w. Ry & Loc Engng—May, 1910. No. 13638 C.

Tests to Determine the Effect of Low Temperatures on Air Brake Hose and Coupling Gaskets. From a paper by W. J. Hatch at meeting of the Air Brake Assn. Describes tests. 1100 w. Ry Age Gaz—May 20, 1910. No. 14139.

Air Pumps.

Air Pump Piping. Extracts from the report of the Committee on Air Pump Piping, presented at Indianapolis, before the Air Brake Assn. Ills. 3500 w. Ry & Engng Rev—May 21, 1910. No. 14159.

Depreciation.

Equipment Depreciation and Replacement. William Mahl. A statement showing the per cent of cost of equipment vacated to total original cost for certain roads. 1000 w. Ry Age Gaz—May 20, 1910. No. 14138.

Freight Cars.

Stresses Developed by Collisions of Freight Cars. Col. B. W. Dunn. Explains the necessity of a thorough investigation of these stresses, discussing the tests at Altoona and their results. Ills. Also general discussion. 9500 w. Pro N Y R R Club—April 15, 1910. No. 14279.

Railway-Car Construction in America (Mitteilungen über eine Studienreise nach Amerika, insbesondere über Eisenbahnwagenbau). Herr Nicolaus. A German view. Ills. 7000 w. Glasers Ann—April 15, 1910. No. 14202 D.

New Closed and Covered Cars, Entered from the Ends, for Transportation of Automobiles on the Paris-Lyons-Mediterranean Railway (Note sur les nouveaux Wagons converts et fermés avec Entrée par Bouts, pour le Transport de Voitures automobiles, de la Cie. P. L. M.). M. Lancremon. Illustrated description. Plates. 1000 w. Rev Gen d Chemins de Fer—April, 1910. No. 14009 G.

Locomotive Boilers.

Report on the Question of Improvements in Locomotive Boilers. Johann Papp. Discusses practice in Austria-Hungary, Rumania, Bulgaria, Servia and Turkey with boilers with smoke tubes, damages, purification of feed-water, etc. 14300 w. Bul Int Ry Cong—April, 1910. No. 14363 G.

Locomotive Construction.

Report on the Question of the Use of Steel. Otto Hönigsberg. Report for countries belonging to the "Verein Deutscher Eisenbahn-Verwaltungen" on the use of special steel of high resistance in the making of parts of locomotives and rolling-stock. 15400 w. Bul Int Ry Cong—April, 1910. No. 14366 G.

Locomotive Costs.

Increases in Motive Power Expenses Due to Severe Weather. Examines the heavy increase in the expense of motive power of various railways, especially in the West, due, it is believed, to severe weather conditions. 1500 w. Ry Age Gaz—May 13, 1910. No. 13899.

Locomotive Design.

British Engineers on Compounding and Superheating. Thomas Reece. Gives a statement by Mr. George Hughes of the present position of British experience in these matters, and a report of investigations and comparative tests. 1600 w. Mach, (Ry Ed)—May, 1910. No. 13911 C.

Locomotive Fuels.

An Efficient Fuel Department. Description of the organization, methods of accounting and operation of the fuel department of the A., T. & S. F. Ry. which has shown remarkable results. Ills. 3500 w. Am Engr & R R Jour—May, 1910. No. 13832 C.

Locomotive History.

Links in the History of the Locomotive. Information concerning the Blenkinsop rack locomotive, of 1812. Also description translated from the French. 3000

w. Engr, Lond—April 29, 1910. No. 13861 A.

Locomotive Inspection.

A General Locomotive Inspection. R. H. Rogers. An account of the method of procedure, some of the results and the conclusions following a detailed individual inspection of over fifteen hundred locomotives of all types and sizes. 4500 w. Am Engr & R R Jour—May, 1910. Serial. 1st part. No. 13835 C.

Locomotive Oscillations.

The Stability of Locomotives (Considerazioni sulla Stabilita delle Locomotive). E. Grismayer. A mathematical discussion. Serial. 1st part. 7500 w. Ann d Soc d Ing e d Arch Ital—March 15, 1910. No. 14037 F.

Locomotive Performance.

Locomotive Performance on Grades of Various Lengths. Beverley S. Randolph. Gives data collected from practical operation of various roads, with explanation. 2500 w. Pro Am Soc of Civ Engrs—April, 1910. No. 14339 E.

Locomotives.

Recent Developments in American Locomotives. A review of recent types built for the different railway lines. 3500 w. Engr, Lond—May 13, 1910. No. 14251 A.

Consolidation Locomotive, Chicago, Milwaukee & St. Paul. Illustrated detailed description. 600 w. Ry Age Gaz—May 6, 1910. No. 13814.

Passenger 4-6-0 for the Seaboard Air Line Railway. Illustrated description. 600 w. Ry & Loc Engng—May, 1910. No. 13637 C.

The Latest Giant Freight Engine. Illustrated description of the large articulated freight engine for use on the heavy grades of the Delaware & Hudson R. R. 600 w. Sci Am—May 28, 1910. No. 14396.

Atlantic Type Locomotives for the Baltimore & Ohio. Illustrated detailed description of type known as "A-3," a straight-forward design of high-speed engine. 1000 w. Ry Age Gaz—May 20, 1910. No. 14140.

Mallet Articnlated Compound Locomotive. 2-6-6-2 Type. Illustrated description of locomotive design which is arranged to burn lignite and is equipped with a high degree superheater and reheater and a very large capacity feedwater heater. 1200 w. Am Engr & R R Jour—May, 1910. No. 13833 C.

Mallet Locomotive for the Burlington. Illustrated detailed description of the 2-6-6-2 type built for the C., B., & Q. Ry., with reheater and feed-water heater. 1800 w. Ry Age Gaz—May 13, 1910. No. 13901.

New Model Locomotive at South Kensington. Describes a sectional model of a 6-wheeled single driven engine of the type generally used on British railways about 1840. 900 w. Engr, Lond—April 29, 1910. No. 13863 A.

Heavy Narrow Gage Pacific Type Locomotive for the Central South African Railways. Illustrated detailed description. 1500 w. Ry & Engng Rev—April 30, 1910. No. 13658.

Six-Coupled Locomotive for the Tientsin-Pukow Railway, China. Illustration, with brief description. 400 w. Engng—May 13, 1910. No. 14198 A.

The Garratt Flexible Railroad Locomotive. Illustrated description of a design for operation on steep grades and sharp curves. 1000 w. Sci Am Sup—May 28, 1910. No. 14398.

Powerful Freight and Passenger Locomotives for a Narrow Gauge Railway. Illustrated description of a Mallet compound 2-6-6-2 type, and a Pacific type locomotive recently constructed for the Central South African railway. 2000 w. Am Engr & R R Jour—May, 1910. No. 13836 C.

The 3/6 Coupled Express Locomotives, Series 210, of the Austrian State Railways (Die 3/6-gekuppelten Schnellzuglokomotiven Serie 210 der k. k. österreichischen Staatsbahnen). Herr Metzeltin. Detailed description. Ills. 6500 w. Zeitschr d Ver Deutscher Ing—April 2, 1910. No. 14232 D.

Recent Experiments on the Application of the Steam Tubrine to Locomotives (Recenti Esperienze sulla Applicazione delle Turbine a Vapore alle Locomotive). G. Belluzzo. Reviews results of tests made in Italy. Ills. 1200 w. Industria—April 10, 1910. No. 14038 D.

Locomotive Safety Valves.

Safety Valve Adjustment. Explanatory comments. 1000 w. Ry & Loc Engng—May, 1910. No. 13639 C.

Motor Cars.

Report on the Question of Motor Vehicles. T. Hurry Riches. Report for Great Britain and colonies on the use and cost of motor vehicles or self-moving cars. Ills. 17000 w. Bul Int Ry Cong—April, 1910. No. 14364 G.

Accumulators for Electric Motor Cars (Ueber Akkumulatoren für Eisenbahn-Triebwagen). M. Büttner. Discusses the extension of the use of electric motor cars and describes types of batteries in use. Ills. 4500 w. Elek Kraft u Bahnen—April 14, 1910. No. 14222 D.

Shops.

Car Repair Shop Notes from the Erie Railroad at Buffalo. Roy V. Wright. Ilsutrates and describes methods and interesting work. 3000 w. Ry Age Gaz—May 6, 1910. No. 13813.

Locomotive Building at the Juniata Shops. Ralph E. Flanders. Illustrates and describes machine shop work on axles, wheels, centers, tires and crank pins. 5000 w. Mach, (Ry. Ed.)—May, 1910. No. 13910 C.

Train Resistance.

Freight Train Resistance. Prof. Edward C. Schmidt. Describes tests made to determine its relation to average car weight. Ills. 11000 w. Jour Am Soc of Mech Engrs—May, 1910. No. 14329 F.

NEW PROJECTS.

Italy.

The Splugen Pass Railway (Il Passaggio ferroviario dello Spluga). Giuseppe Colombo. A general discussion of the project. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—March 15, 1910. No. 14036 F.

PERMANENT WAY AND BUILDINGS.

Bridges.

Report on the Question of Strengthening the Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains. Eugene Randich. Report for France and Italy on methods of strengthening metal bridges. Ills. 30500 w. Bul Int Ry Cong—April, 1910. No. 14365 G.

See also under CIVIL ENGINEERING, BRIDGES.

Construction.

Construction of the Kansas City, Mexico & Orient Ry. Gives an account of the construction work, with illustrated descriptions of some of the engineering work. 3000 w. Ry & Engng Rev—April 30, 1910. No. 13657.

Curves.

The Application of the Hallade Method of Joining Curves (Résumé, Modèles et Tables numériques pour l'Application de la Méthode de Raccordement des Courbes donnée par. M. Hallade). Gives tabular data and examples for the application of the method proposed by M. Hallade in 1908. Ills. 10000 w. Rev Gen d Chemins de Fer—April, 1910. No. 14010 G.

Freight Sheds.

The Location and Arrangement of Freight Houses and the Handling of House Freight. M. A. Long. Brief description of present arrangements for cities and smaller places. Ills. 1500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14356 N.

Mail Exchange.

The Sebree Mail Exchanging Device. Illustrated description of a devise being tested by the Illinois Central R. R. 700 w. Ry & Engng Rev—May 7, 1910. No. 13806.

Rail Joints.

Report on the Question of Rail-Joints. Mr. Blum. Report for all countries except France, Belgium, Italy, Spain, Portugal, Austria-Hungary, Rumania, Bulgaria, Servia, Turkey, Egypt and countries using the English language. Ills. 6000 w. Bul Int Ry Cong—April, 1910. No. 14367 G.

Report on the Question of Rail-Joints. Mr. Chateau. Report for France, Belgium, Italy, Spain, and Portugal on practice of reducing the number of joints by increasing the length of the rails, welding and strengthening joints. Ills. 14000 w. Bul Int Ry Cong—April, 1910. No. 14362 G.

Stations.

The Terminal in Buffalo. George Cary. Brief illustrated description of the plans for a union station, and matters related. 1300 w. Jour of Pro Am Inst of Archts —Dec. 16, 1909. No. 14359 N.

New Union Passenger Station, Winnipeg. Illustrated detailed description. 1500 w. Eng Rec—May 21, 1910. No. 14156.

Switches.

Report on the Question of the Operation of Switches and Signals. L. H. N. Dufour. Report for Holland on improved centralized installations, and arrangements adopted. Ills. 14000 w. Bul Int Ry Cong—April, 1910. No. 14361 G.

Terminals.

A Terminal Station. J. Vipond Davies and J. Hollis Wells. Illustrations, and description of the Hudson terminal buildings in New York City, explaining the conditions and the development. 7500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14357 N.

See also Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Ties.

Keeping Records of Test Ties. F. J. Angier. Describes the system used by the Chicago, Burlington & Quincy. 1200 w. Ry Age Gaz—May 6, 1910. No. 13807.

TRAFFIC.

Car Interchange.

Report of Standing Committee on Revision of M. C. B. Rules of Interchange. A discussion of the recommendations of the Committee. 11000 w. Pro Ry Club of Pittsburgh—March 25, 1910. No. 14278 C.

Report of the Committee on the Master Car Builders' Rules of Interchange. Discussion of the rules in their order. 14500 w. Pro W Ry Club—March 15, 1910. No. 14276 C.

Coal.

See Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Freight Handling.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Freight Rates.

Reasonable Freight Rate. F. H. Plaisted. Discusses the making of rates aiming to remove public misapprehension. 4000 w. Ry Age Gaz—May 13, 1910. Serial. 1st part. No. 13897.

Fair Return on the Value of Property a Fallacious Standard. Walker D. Hines. From an address before the Traffic Club of Pittsburgh. A discussion of rates and equitable bases for government regulation. 1700 w. Ry Age Gaz—May 6, 1910. No. 13809.

Mine Suspensions.

Economic Losses Due to Mine Suspensions. Eugene McAuliffe. A discussion of the losses from this cause, and the possible remedy; referring to legislation in Canada and the benefits. 2500 w. Am Engr & R R Jour—May, 1910. No. 13834 C.

Passenger Rates.

Reformed Passenger Tariffs in Italy. Ph. Tajanie. An account of the tariff reforms made by roads under state management, explaining the new tariff. 1800 w. Ry Age Gaz—May 6, 1910. No. 13810.

STREET AND ELECTRIC RAILWAYS.

Cars.

Vestibule or No Vestibule. Henry Mozley. Considers the advantages, construction, design, and use. Ills. 1200 w. Tram & Ry Wld—May 5, 1910. No. 14107 B.

Dublin.

The Dublin United Tramways Company. Illustrates and describes the lines operated by the United Company, giving information in regard to rolling-stock, traffic, power-stations and other subjects of interest. 2500 w. Tram & Ry Wld—May 5, 1910. No. 14106 B.

Electric Traction.

The Development of Electric Railways in the United States (Développement des Chemins de Fer électriques aux Etats-Unis d'Amérique). H. Marchand. A review of the development of the various traction systems. 1000 w. Soc Belge d' Elecns—April, 1910. No. 14000 E.

Italy.

The Padua-Fusina Alternating-Current Railway (Die Wechselstrombahn Padua-Fusina). C. H. Eigenheer. Illustrated detailed description of line and rolling stock. Serial. 1st part. 1600 w. Elek Kraft u Bahnen—April 23, 1910. No. 14223 D.

Locomotives.

Electric Locomotives with Connecting Rods (Comportamento delle Bielle motrici nelle Locomotive elettriche). Emidio Pacilli. A study of this mode of transmission in electric locomotives. Ills. 2200 w. Industria—April 17, 1910. No. 14040 D.

Paris.

The Railways of Paris (Die Pariser Stadtbahn). E. A. Ziffer. A brief description of the construction, stations, rolling stock, operation, etc., of the Metropolitan of Paris. Ills. 5500 w. Mitt d Ver f d Ford d Lokal u Strassenbahnwesens—March, 1910. No. 14030 F.

Rail Joints.

Rail Joints for Interurban Lines (Il Giunto nella Tramvia extraurbana). Illustrates various types in use. 1800 w. Ing Ferro—April 1, 1910. No. 14043 D.

Railless.

Railless Electric Railways (Gleislose elektrische Bahnen). A. Heller. A brief discussion and description of cars for trackless trolley lines. Ills. 2200 w. Zeitschr d Ver Deutscher Ing—April 30, 1910. No. 14242 D.

Single-Phase.

Blankenese-Ohlsdorf High-Tension, Single-Phase Railway. Gustav Dietl. Illustrates and describes characteristics of the new equipment. 900 w. Elec Wld—May 12, 1910. No. 13915.

Stations.

Inter-Urban Stations and Trolley Traffic in City Streets. Albert Kelsey. Brief discussion of arrangements of tracks, waiting stations, etc. 2500 w. Jour of Pro Am Inst of Archts—Dec. 16, 1909. No. 14360 N.

Subways.

The Proposed Suburban Railways of Sydney. C. O. Burge. Map and discussion of the proposed lines. 2500 w. Engr, Lond—April 29, 1910. No. 13856 A.

How Chicago is Solving Its Rapid Transit Problem. D. H. Stevens. Illustrated description of the proposed plan for placing all tracks, surface and elevated, that enter the business zone, below street level. 1200 w. Sci Am—May 28, 1900, No. 14307.

Subway Ventilation.

Ventilation of the Hudson River Tubes. A. W. Hodgson. Describes the system installed in the tunnels of the Hudson & Manhattan R. R. Co., reporting test. Ills. 3000 w. Heat & Vent Mag—May, 1910. No. 14306.

Three Phase.

Three-Phase Railways in Europe. Rudolph E. Hellmund. Brief illustrated descriptions of features of the European three-phase roads. 3500 w. Elec Jour—May, 1910. Serial. 1st part. No. 14287.

Valuation.

Valuation of the Puget Sound Electric Railway. Henry L. Gray. Describes the lines and methods of valuation. 8000 w. Engng Con—May 25, 1910. No. 14395.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m* Glasgow.
Journal Western Soc. of Eng. *b m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE MANUFACTURE OF FRENCH AEROPLANES.

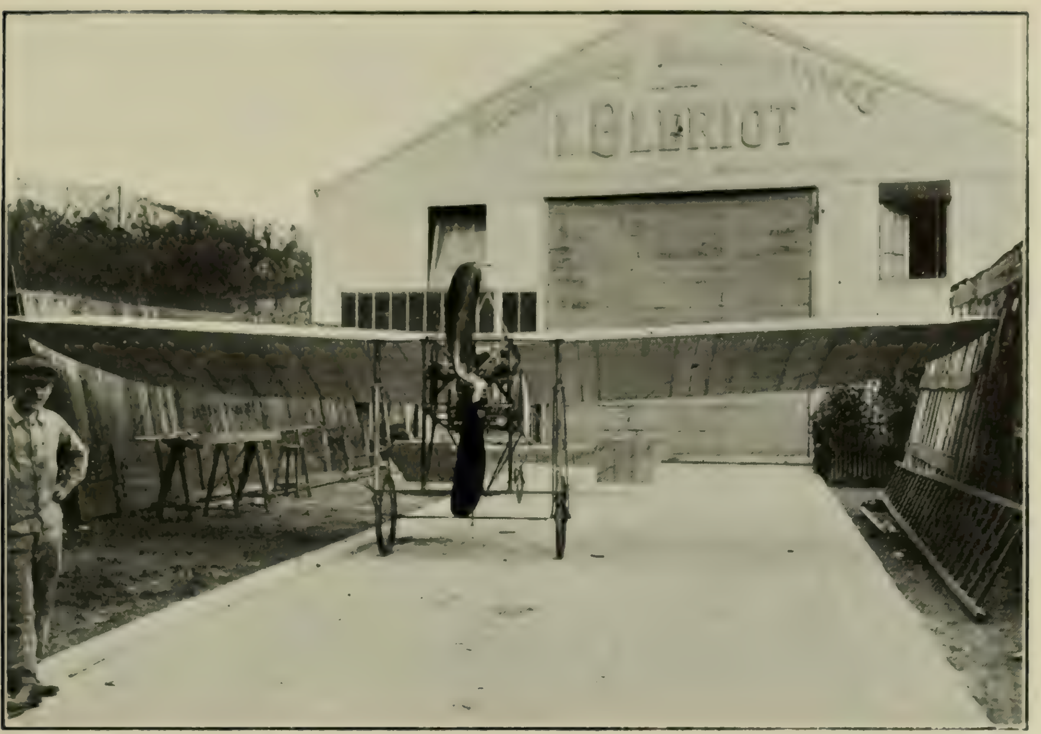
By Warren H. Miller.

The picturesque and emotional appeal of mechanical flight, in our estimate, has caused popular imagination to run away with judgment in tracing the future of the aeroplane. However, dismissing the question of its economic or commercial importance, it is certainly a highly interesting mechanical development, with some industrial significance so far as manufacture is concerned. From this point of view Mr. Miller's review of the "state of the art" in France is prepared. A second article, following in September, will deal more specifically with the motors used in the leading French aeroplanes.—THE EDITORS.

DURING the last year or so, the main principles which govern the design of aeroplanes have become pretty fairly fixed in the minds of the French constructors, and the business side of their manufacture has developed enormously. In fact, to find Blériot passing his two hundred and fiftieth aeroplane sold; Farman, Sommer, Antoinette, and Voisin anywhere from twenty to fifty aeroplanes apiece on the books; all of them issuing handsomely illustrated catalogues of their standard sizes and types of manufactured aeroplanes, and owning from one to three factories apiece for their manufacture—this is striking evidence how far beyond the experimental stage the manufacture of French aeroplanes has progressed.

Each house has its *école;* some of them, like Blériot and Antoinette, two of them on different aerodromes, as the Antoinette *Ecole de Pau* and the Antoinette *Ecole de Mourmelon.* Each has its *directeur, moniteur,* and staff of pilots, and the total of pupils enrolled or recently graduated aggregates over four hundred. Their principal function is to teach intending purchasers of new machines how to run them before essaying any flights on their own machines. One must have a pilot's license before being allowed to fly at large on the aerodromes. The price of the course is about 1,000 francs and the students number scores.

Among the few principles which have become so established that no aeroplane can be considered scientifically correct that ignores them are, first, the discovery of Langley that a plane is more efficient if presented with its longest dimension across the wind, than in any other position. If turned the other way, or if square, it is markedly less efficient. The reason is that the kinetic energy of the relative speed of each particle of air is at once taken out of it the instant that it comes in contact with the plane. It is then dead and inert, and the sooner it is passed off astern and fresh particles of air utilized, the better. Therefore a long wing like the biplane, of the proportions of, say 10:2 in length and width, is immensely more efficient with the length 10 presented to the wind, than if turned lengthwise, (as in artists' illustrations of air-ships, for example,) and the small dimension 2 presented to the wind. The second well-established principle is that a curved plane has a great deal more lifting power than a flat one. The best curvature has been found to be about 1 : 12 cord of the arc. The reasons are somewhat more complex than those for the position of the plane for maximum efficiency. Lillienthal, the German *glissardier,* was the first to investigate extensively the actual causes of this phenomenon, and his treatises on the subject explain the matter as well as need be. The third principle is that of steadying the plane laterally while in flight. Obviously there is no great trouble in preventing the thing pitching, as either a tail with feathering or a small plane in front will be ample to preserve the fore-and-aft stability while in flight; but sidewise it is a different matter. One would think that the principle of Santos-Dumont, as exploited in his 14-*bis* biplane, would be ample to insure an even keel; but, unfortunately, the principle of having the center of gravity below the point of support does not work as efficiently in air as on the sea. There are numerous planes employing this idea, the wings extending in a wide V with all the weight at the bottom. It should then always remain automatically upright—and it will, when falling, just like a shuttlecock; but when under way, the aeroplane can dip considerably from one side to the other because it is swimming through the air horizontally, not falling, and the forces of suspension passing along the frame to the load make the feeble couple between the load and the center of suspension (wherever that may be) of very little significance. Undoubtedly the best way to keep the aeroplane on an even keel is to use some of the force obtained from its passage through the air to keep the plane steady, and this can be done either by warping the wing-

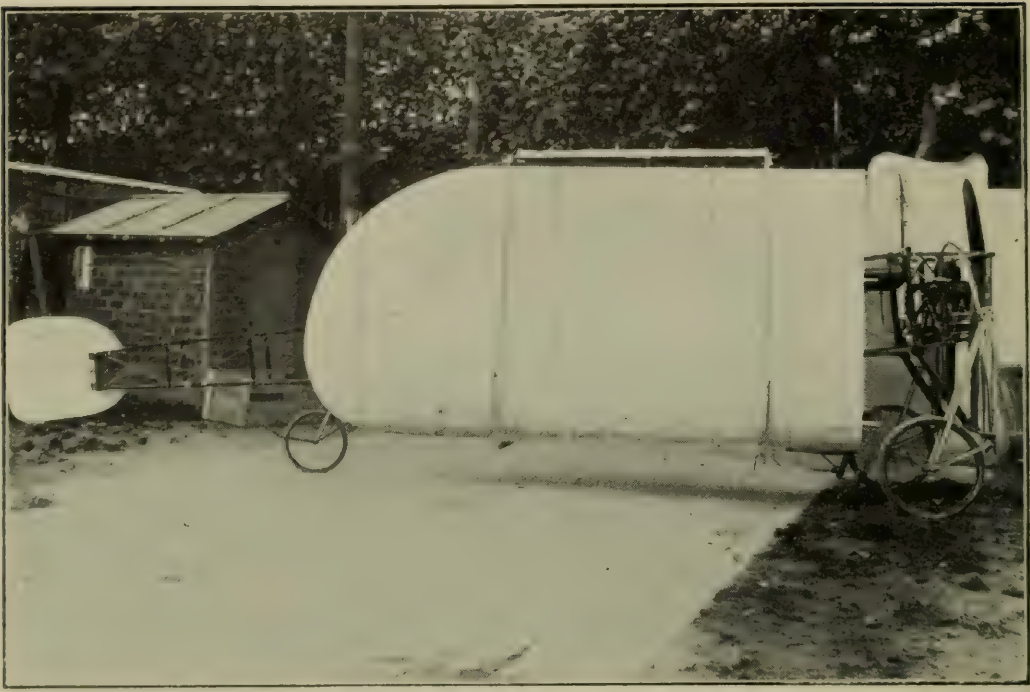


BLÉRIOT XI IN FRONT OF NEUILLY FACTORY.
Equipped with Anzani motor.

tips, or by putting on little wings at the tips which can be moved out of the general angle of the plane, and thus exert a lateral couple, or else by warping the horizontal feathering. Still another way is the vertical cellular plane principle of the Voisin and other French planes, though this is not as positive in its action as the others, because the plane can tip considerably before it comes into play. It is the use of this warping principle and its patent by parties in America that has stirred up such a row among the French, but a discussion of the pros and cons of it lies outside this article.

With these three principles properly provided for in the aeroplane, and a light motor, one has the means for flight through the air; and their combination in five different ways has brought into the field of French aviation the five large manufacturing concerns mentioned above.

Beginning with the Blériot *Compagnie Aeronautique,* main offices 16 Rue Duret, Paris, and four factories in the suburbs, we find an enthusiastic *clientèle* buying freely of the two standard sizes, Blériot XII and XI, with M. Blériot himself constantly on the grounds at the Pau aerodrome, supervising flights, etc. No. XI is the same size as that in which Blériot crossed the Channel. It weighs 750 pounds, has a wing surface of 150 square feet, length from tip to tip, 28 feet 3 inches, length from front of screw to tip of rear rudder, 26 feet 5

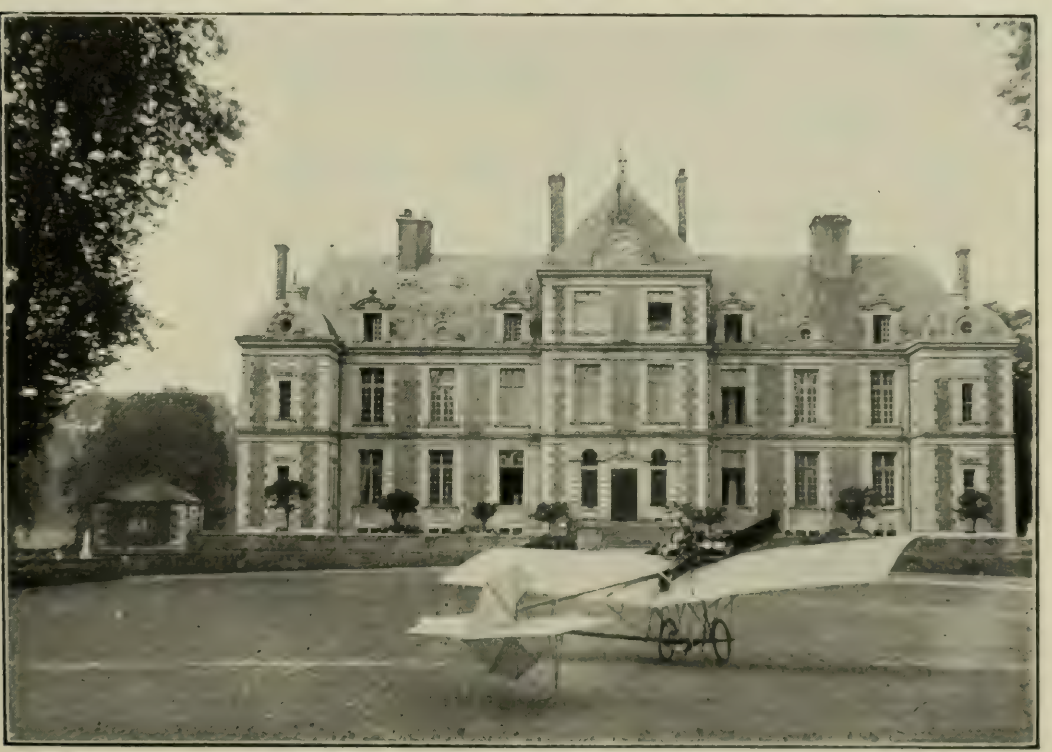


BLÉRIOT XI WITH WINGS FOLDED.

inches. It is sold on prompt delivery with a 25 horse-power Anzani motor, with a guaranteed speed of 44 miles an hour. The No. XII is considerably larger and heavier, and will take a passenger. It weighs 1,050 pounds, has a wing surface of 292 square feet, length from tip to tip of 32 feet, and length from front of screw to tip of rudder of 22 feet 5 inches. It is furnished with a 60 horse power E. N. V. motor, and a speed guaranteed of 48 miles an hour. Both aeroplanes have an angle of incidence of 7 degrees of the wings with the horizontal, the angle being measured by the cord of the arc and a horizontal line. Both ensure lateral stability by warping the main wings, but the latest model of No. XII has this command transferred to the tail. In it, as will be seen by the cuts, the framework is enclosed in light cloth, owing to the recent discoveries this year that the frame offers very much less resistance to the air when covered by some smooth surface, the weight of the latter being amply compensated for by the gain in speed. The frame of the aeroplane and wings is of ash covered with rubberized linen, all tension members being of steel piano wire.

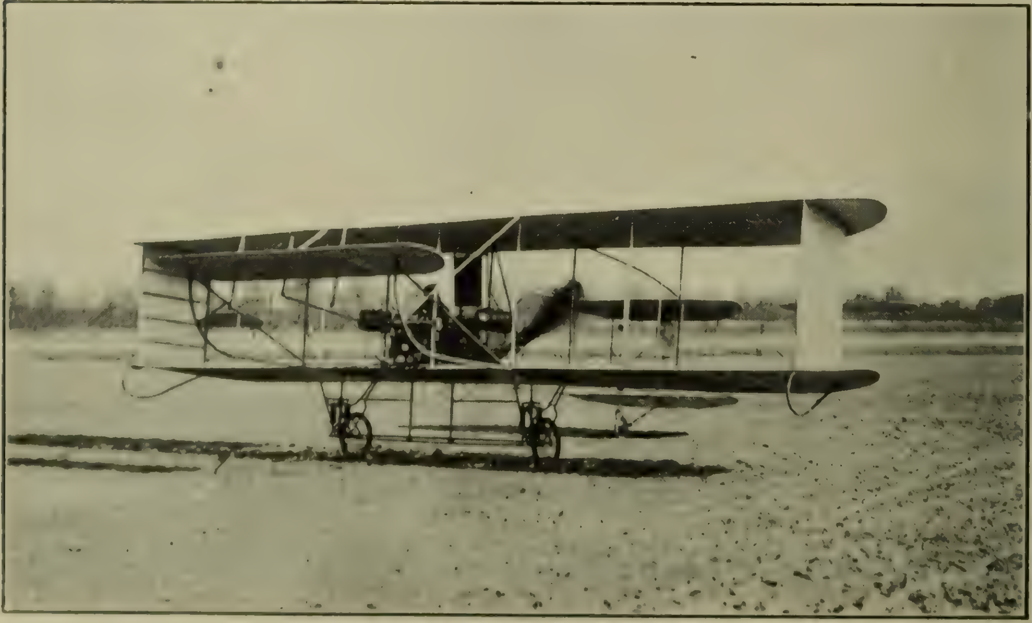
Closely allied to the Blériot is the Antoinette monoplane, made famous chiefly by the exploits of Hubert Latham. The control of lateral stability is by torsion of the main wings, though in *Antoinette V*, in which Latham made his splendid performances, the control was by little wings at the rear outer corners of the large ones. The frames of both the wings and body of this aeroplane are of steel, and the wings are covered with varnished linen on both sides, yet do not weigh more than 0.2 pound per square foot. The machine is only made in one size, with a 50 horse-power Antoinette motor. It weighs 1,150 pounds, has a wing surface of 345 square feet, is 48 feet 6 inches from tip to tip, and is 37 feet 9 inches from front of screw to tip of rudder. It always shows great stability of flight, doubtless due to its heavy solid construction and generous vane surfaces in the tail. It was the first one to have its frame covered with varnished linen, so as to prevent loss by the friction of the air strumming through the frame members.

The third monoplane to be mentioned is the little *Demoiselle II.* of Santos-Dumont. This is made by the Clément-Bayard Company, so well-known for their automobiles and dirigible balloons. It is the smallest of the monoplanes, having only 120 square feet of lifting surface, and is in the line that it seems the monoplanes will eventually take, of being used for single travel, like the bicycle during the '90's. The biplanes, with no physical impossibilities prohibiting their development into multiplanes, appear to have the logical elements of heavy duty and passenger transportation. The plans of this aeroplane are given in the illustrations. The frame is of steel throughout, and the motor, a Clément-Bayard 25 motor, is mounted at the junction of the wings. These are set in a V, as in all Santos-Du-



THE "DEMOISELLE" OF SANTOS-DUMONT.

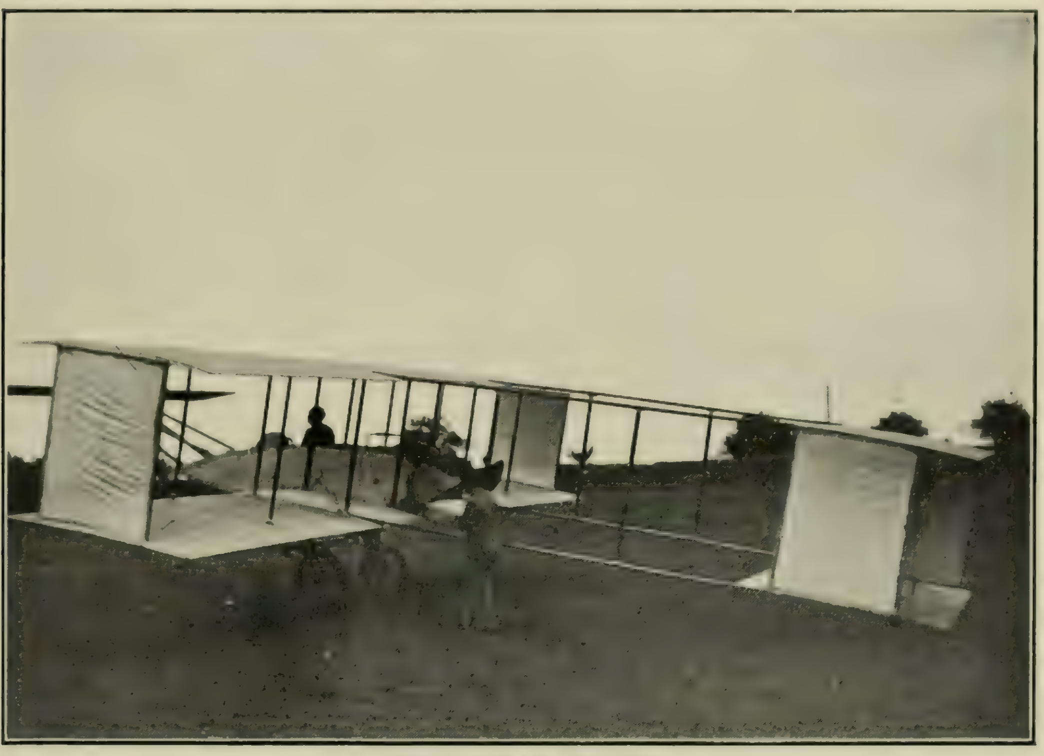
mont's designs, but the lateral stability is further assured by warping of the wings themselves. Considerable study has been shown in the arrangements for control, which form so great a part of the worries of the man at the helm. The pilot has to perform five manœuvres in managing an aeroplane, some of them all at once, viz. 1, governing depth and longitudinal equilibrium; 2, steering; 3, governing lateral stability (by warping); 4, managing the carburetor; 5, advancing the spark. All of the aeroplanes have various ingenious schemes for doing three or four of these things at once—Blériot by various positions of the shaft of the steering wheel, Antoinette by three wheels and a foot lever; Dumont manages the motor with the feet, the depth rudder with his right hand, and steering rudder with his left. This leaves the lateral stability with no hand or foot to take care of it, so he has attached the wires that warp the aeroplane to the seat where the pilot sits. By simply bending away from the direction of dipping, the plane is warped, by the stock of the seat, so as to bring it level again. Details of *Demoiselle II;* weight 230 pounds, spread of wings 18 feet 0 inches, length 19 feet 6 inches.



THE CLÉMENT-BAYARD BIPLANE.

The first of the French biplanes is undoubtedly the Farman. It holds four of the world's records at present, that of height by Paulhan, 1,520 metres, of distance by H. Farman, of 232 kilometres, of duration by H. Farman of 4 hours 17 minutes 3 seconds, and of cross-country flight by M. Farman. It will carry three to four passengers, and is very easy to handle. It is manufactured by Messrs. Farman, Kellner & Neubauer, 218 Boulevard Périère, Paris, factory at

Boulogne-sur-Seine. When you purchase, a flight of fifteen minutes with your aeroplane by one of the company's pilots constitutes the acceptance test. The biplane is made in one size, weighing 1,200 pounds, 430 square feet, carrying surface, 32 feet 9 inches length over all of plane, 39 feet 6 inches length from tip of forward governing plane to end of rear supporting cell; speed 40 miles per hour.

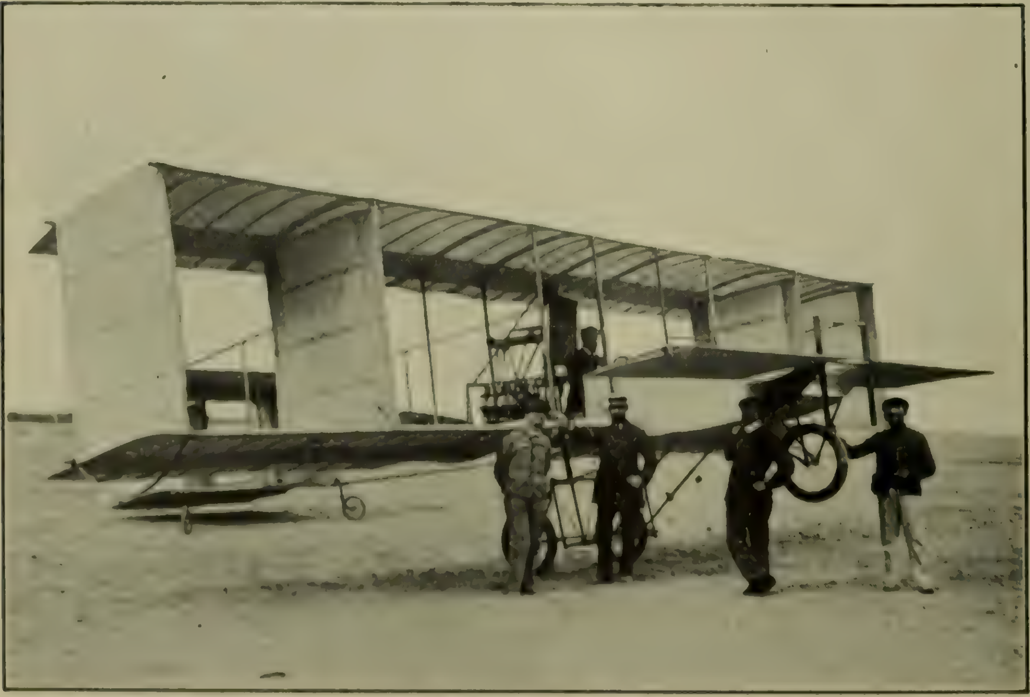


THE FARMAN BIPLANE.

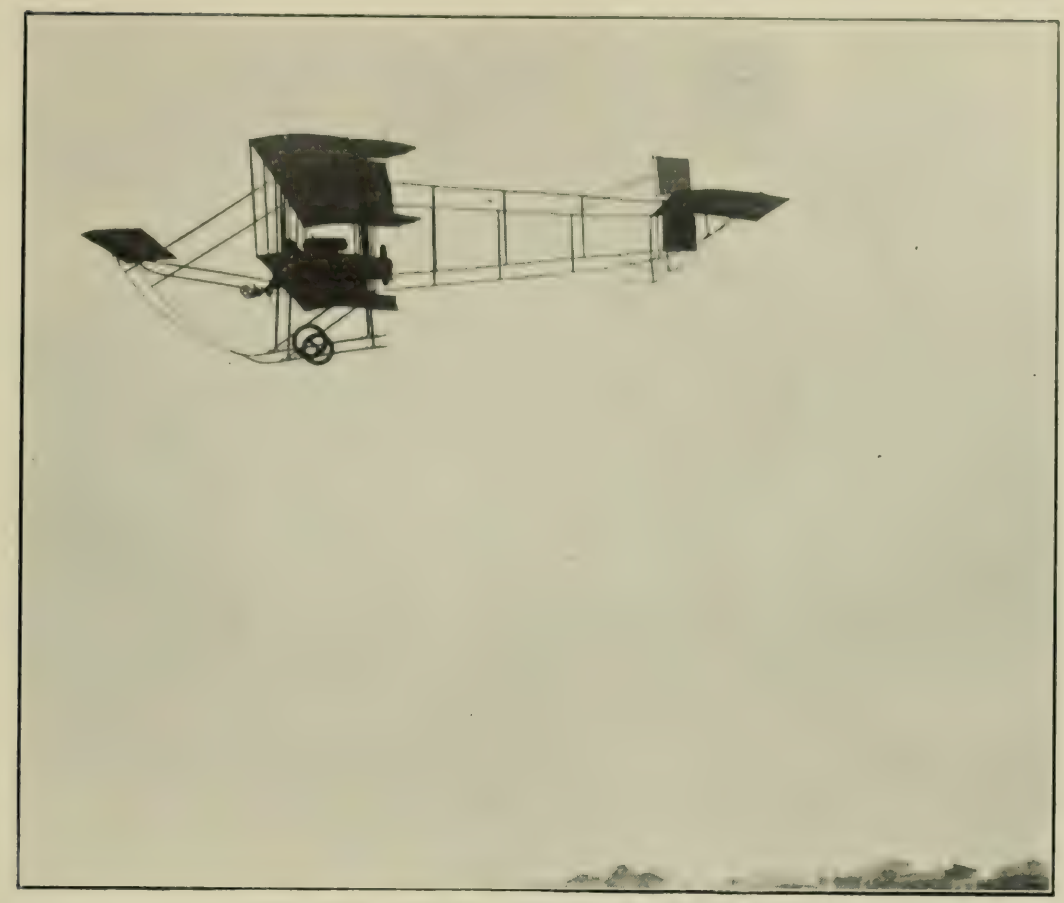
Equipped with 60 horse-power Renault motor, or with 50 horse-power Gnôme motor. The frame is of ash with piano-wire tension members. As will be noticed from the cut, the screw, which is made of wood glued up in sections, is placed behind the main plane, thus avoiding the confusing effect of a whirling screw in front of your eyes, and also possibly giving a trifle better efficiency, as the plane only meets air currents in right lines. With the long tail astern, and a governing plane out in front, the control of longitudinal stability is easy and perfect. It is managed by the steering wheel, the joints being ball-bearing, as are all those about the apparatus. The steering rudder is managed with the feet, and the lateral stability by the main steering wheel, which turns to right or left and raises or depresses the little wings or fins at the rear edges of both planes. The lateral stability is further aided by the vertical planes in both main and rear cells.

The oldest and most famous of the French biplanes is the Voisin, manufactured by MM. Voisin Frères, offices and factory at 34 Quai du Point du Jour, Billancourt (Seine), Paris. Their aeroplane is on the market in one size only, with Gnôme motor. It weighs 1,200 pounds, has a portative surface of 540 square feet, length from tip to tip of wings, 37 feet 8 inches, length from front edge of stability-plane to rear edge of tail-cell, 39 feet 4 inches; speed, with 50 horse-power motor, 40 miles an hour. The stability is assured entirely by the vertical planes, which divide the bi-plane into cells. The tail-cell has the same feature with the rudder mounted inside. In practice it works out about as well as the warping principle, which has been abandoned in the latest types of Blériots and Antoinettes.

The latest of the French biplanes is the Sommer, shown in the illustrations. It has been long known by the cellular men that their planes have a great deal of encumbrance of doubtful utility, particularly in the tail. This can have but little effect as a supporting plane, unless the main weight is placed further astern than at present, as the couple it makes is so great about the center of longitudinal stability as an axis that it cannot support very much more than its own weight. Any further lifting capacity would be simply spent in overturning the plane or in imposing unnecessary work on the forward stability-plane. It will be noted that the Sommer aeroplane has discarded the lower of the tail-planes and placed the rudder further forward in the tail-frame. The cellular feature is discarded in favor of the much-disputed rear-vanes of lateral stability. The whole aeroplane has

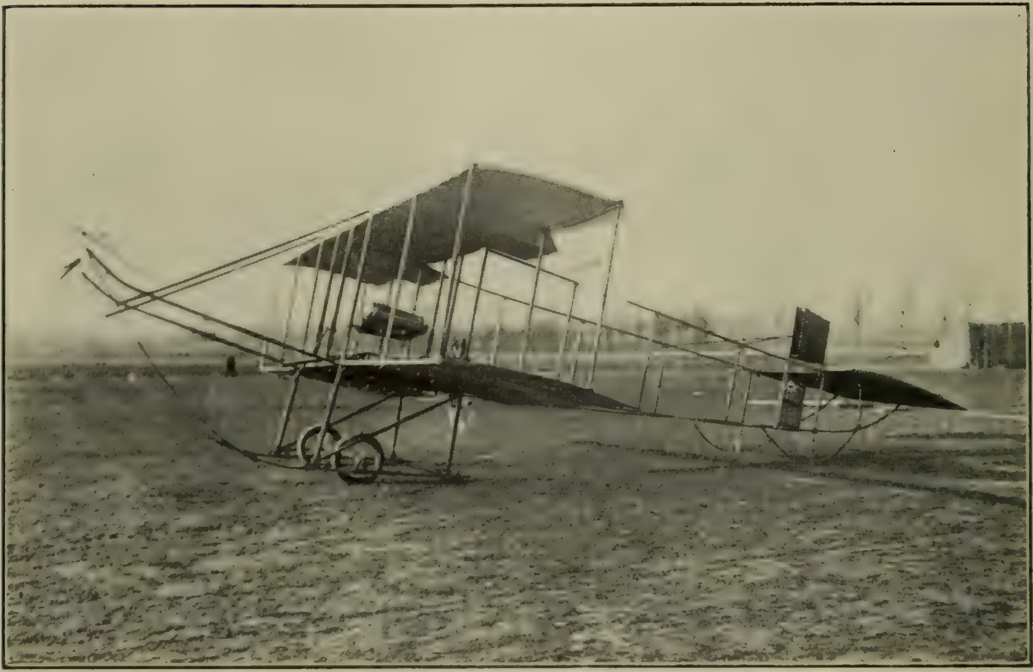


THE VOISIN BIPLANE.



THE NEW SOMMER BIPLANE IN FULL FLIGHT.

greater care for the practical needs of aviation shown in its design than most earlier makes, being, as might be expected, the design of a man already thoroughly familiar with just what requirements are most needed in practice. The arrangements for protection against the shock of landing are very complete and well studied out. The sled frames of Wright have been introduced, in addition to the regular French steel chassis with its deadening springs, which is a feature of every French aeroplane. The sled frame has been substituted for the lower supporting plane in the tail, besides, so that if the aeroplane bobs or teeters on landing, the runners of the sled will protect both the aft tail-plane and the forward stability plane. Unlike the Blériot machines, which have always preferably the members of the frame in light springy woods (better able to withstand shocks of landing, etc.) the Sommer aeroplane has its members entirely in steel. The joints and hinges are of special alloy, and their pins of high-speed steel. The apparatus can be dismounted and reassembled in an hour, without disturbing the chassis, and, when folded up, can be run along ordinary country roads. All the wires of control are double, and the rear plane interlocks with the mechanism of the forward stability-



THE SOMMER BIPLANE AT REST.

plane, so that the pilot has little on his mind in maintaining longitudinal equilibrium.

This machine has made flights with 360 pounds of supercargo. Main construction details are: length across main planes, 32 feet 8 inches; portative surface, 368 square feet; weight with Gnôme 50 horse-power motor, and Chauvière aluminium screw, 670 pounds; speed, 50 miles an hour; planes covered with rubberized linen.

The prices of all the large aeroplanes are close to $5,000; those of the smaller machines (such as the Blériot monoplane), about $2,500.

It will be seen that the Sommer is at present by far the lightest of the biplanes, which, with its portative surface of only 388 square feet enables it to carry such a heavy supercargo, because so much less dead weight is imposed on the aeroplane. The motor-power also drops, or, what is the same thing, the speed increases with the same size motor. Altogether is it a fair hint of what will gradually come to be realized in the future of aviation, as constructional details become more and more perfected. When we review the progress made by the bicycle in a few years, from the heavy iron 70-pound wheels with solid tire of 1890, to the 17-pound beauties of 1900, with their light, strong steel frames and pneumatic single-tube tires, we can form some idea of what will be done in the line of development in the construction of aeroplanes, when once the weight of experience and scientific data enable us to advance in the correct directions.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

V. HIGH-TENSION TRANSMISSION.

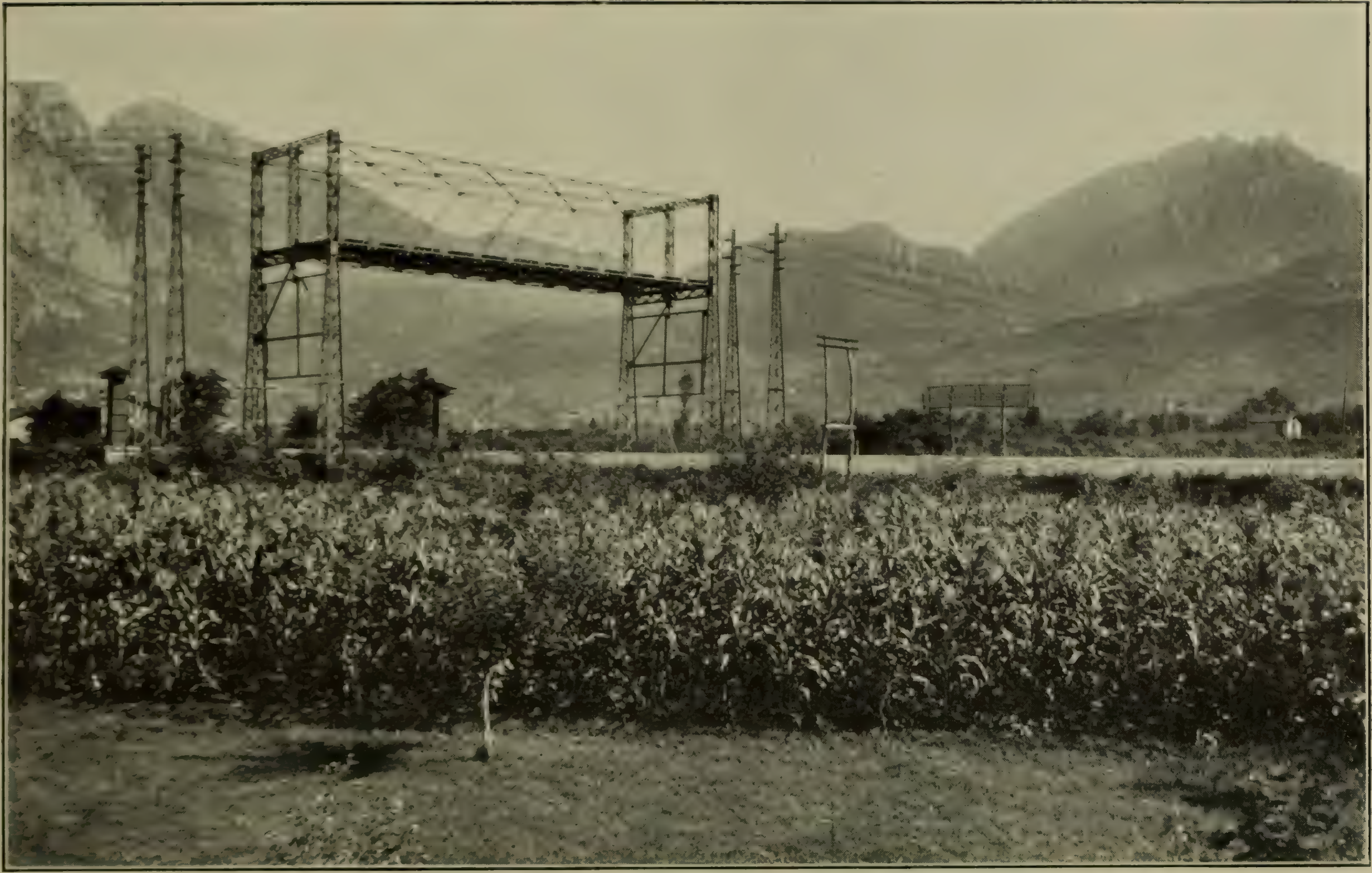
Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. In June he took up water-wheels and the mechanical equipment of the power station. His July article considered the electrical machinery, and he now reviews the transmission and distribution of current. A following paper will take up the financial elements of the case. The whole discussion is addressed not to the specialist in hydroelectric enginering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commerical associates.—THE EDITORS.

A TRANSMISSION line should run at low levels and near highways, to facilitate erection, inspection, and repairs; and the line should be as straight and short as possible in order to minimize first cost, maintenance, line loss, and the expenditure of securing right of way. Where the line runs through mountainous country, high peaks must be avoided because the temperature range between peak and valley is great and atmospheric electrical discharges are frequent. It is therefore better policy to detour the line than to be troubled with atmospheric discharges.

For high-tension lines of some magnitude two separate circuits should be run either on a common line or two separate lines of supports so that one is always in reserve. Each line must be divided into sections, provided with section-switches and by-pass connections so that continuous service may be assured. Stations for linemen, repair shops, etc., may be established for each section, which will cover from 10 to 20 miles of transmission, and from these points inspection and repairs may be undertaken.

Telephone lines for communication between the stations and the main central station must be established. Proper precautionary measures must be taken if run on the transmission line; otherwise the telephone lines should be carried on separate poles.

For carrying the conductors of the main transmission system the following pole and tower constructions are used, viz: wooden poles, concreted wooden poles, reinforced-concrete poles and towers, steel-pipe poles and towers, and structural-steel towers. Of this variety wooden poles and structural steel towers are chiefly used.



TOWERS AND CROSSING OF THE 50,000-VOLT BRUSIO TRANSMISSION SYSTEM, SWITZERLAND-ITALY.

Where the transmission line runs through a section or in the vicinity of a forest district where poles may be cut, the wooden pole is preferably selected on account of cheapness, little or no transportation, and ease of erection. The disadvantages of wooden poles are, that they decay very rapidly; more insulators are required owing to the short spacing between poles; they are easily destroyed by storm, lightning and fire. The ordinary type of line construction is a single pole. Other types are the "A" frame and "H" frame, both of which require two poles. The kind of wood used depends upon the locality, the cost, and factor of safety desired. In western American transmission lines spruce and fir are much used, while in California redwood prevails. Cedar and chestnut are also used, white pine, owing to its cheapness, is used most extensively, but it has the disadvantage of short life and inferior strength.

The life of wooden poles depends upon the nature of the wood, chemical treatment, and climatic conditions, and also upon the character of the soil. Redwood and cedar poles may last 20 years under favorable conditions, while the life of chestnut is about 15 years and that of pine and white cedar 10 years. When chemical treatment is applied the life of all wooden poles may be materially increased. Poles come in lengths varying from 30 to 60 feet, and they are set with 1-6 to 1-7 of their length in the ground. The cross arms for carrying the insulators are made of first-class wood, such as chestnut, white oak, cedar, redwood, etc. Arms 8 feet long are 4 by 5 in cross section, 3-foot arms about 3 by 4 inches in cross section. They must be properly braced to withstand the strain applied, and fastened to the poles by means of lag-screws.

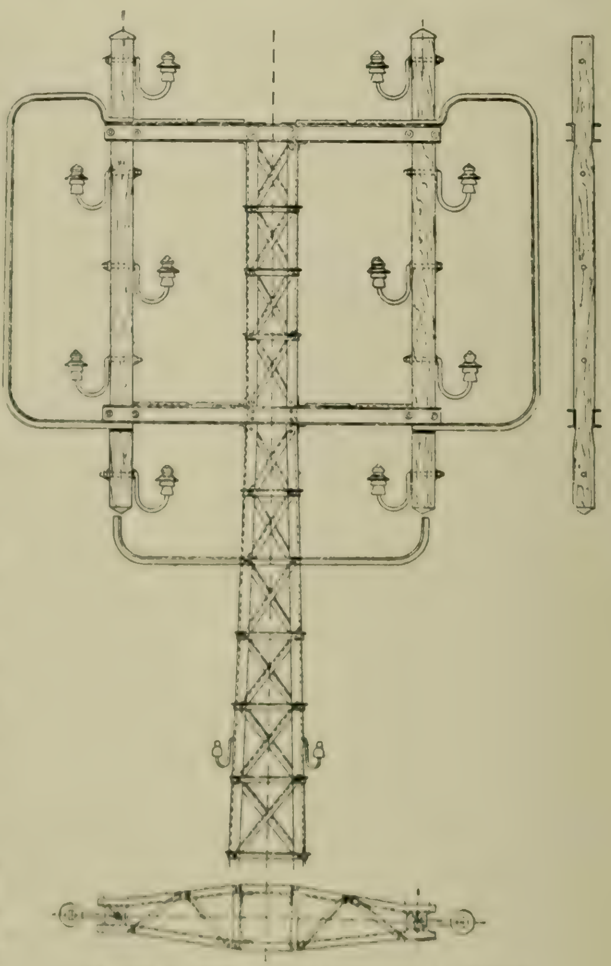
The concreted wooden pole has not been used to any great extent. Up to recently it has been used in Switzerland only, but of late it has been introduced into America. It consists of an ordinary wooden pole covered with a layer about 1 inch thick of concrete mortar. As this coating covers the entire pole it is practically indestructible, and fewer poles and insulators are needed. The concrete-block setting frequently used with ordinary poles is thus eliminated.

Reinforced-concrete poles are made in a manner similar to concrete piles. They are cast in forms and reinforced with iron or steel rods. Another type of reinforced-concrete poles is the hollow pole known as the "Siegwart," developed in Switzerland. They are of a tapered design and made by machine to any length desired. These poles are estimated to have a life of 50 years, and during this period will cost nothing for maintenance. Comparing such poles of 29 feet in length, the costs of poles at the end of 50 years are estimated at

$20 for this concrete pole, $50 for an iron pole, and $53 for a wooden pole; all including maintenance, repairs, and renewals. Some tests on poles of this type 32 feet 9 inches long show a deflection of 2¾ inch with a tensile strain of 15,000 pounds.

The simplest form of steel-pipe poles is that employing a single pipe with a cross arm. For more rigid and higher constructions two-legged pole frames or three-legged towers may be used. The latter type will be found on the Canadian side of the Ontario Power Company's transmission system and also in an earlier system installed at Juancatalan, Mexico, which was one of the first high-tension transmission systems introduced on the western side of the Atlantic.

With the use of high voltage wooden poles are fast being superseded by steel towers. These are made of angle irons, channels, and lattice construction in two, three, and four-leg types. Poles of the two-leg type have been in use for many years in Italy and Switzerland and of late years in Germany and Spain, and are at present being introduced in American practice. As they possess great economical features there is no doubt that they will at some time take a very prominent place in high-tension transmission practice. They are made up of channels or I-beams in "A" or "H" frame type and are lattice-braced. Recent plants for which these have been adopted in Europe are, the seventy-five mile, 52,000-volt Gaucin-Seville, Spain, transmission system; the thirty-two mile, 50,000-volt Moosburg-Munich, Germany, transmission system. Other towers of this type will be found in Eastern Germany and also on the Victoria Falls transmission line in Africa.



PARTIAL DETAIL OF A TYPICAL SWISS TRANSMISSION TOWER.

The following table, based upon tests made upon the different constructions before the contracts for the Moosburg transmission system were let, shows the comparative values of different poles:

	1	2	3	4	5
Res.-Mom. in line direction	990	32.2	33·9	353	52
Res.-Mom. in transverse direction	5,440	32.2	33·9	353	52
Safe load in kilograms..	100	1,800	2,200	870	1,800
Cost in marks, including two cross-arms	35·20	40.35	45·20	80.70	40.00

Referring to the column numbers, No. 1 is a wooden "A" frame structure, 2 is a steel two-pole, 3 is a Mannesmann-tube pole, 4 is a lattice tower of angle iron, and 5 is an I-beam "A" frame. It will be noticed that the last named outstrips the other as to safe load and price. All these towers were designed for a height of 23 feet to the lower insulator and were imbedded 5 feet in concrete blocks.

The above mentioned three-legged steel-tube tower is no more in favor but a substitute has been successfully introduced in which each of the three legs consists of a special U-shaped rolled steel member.

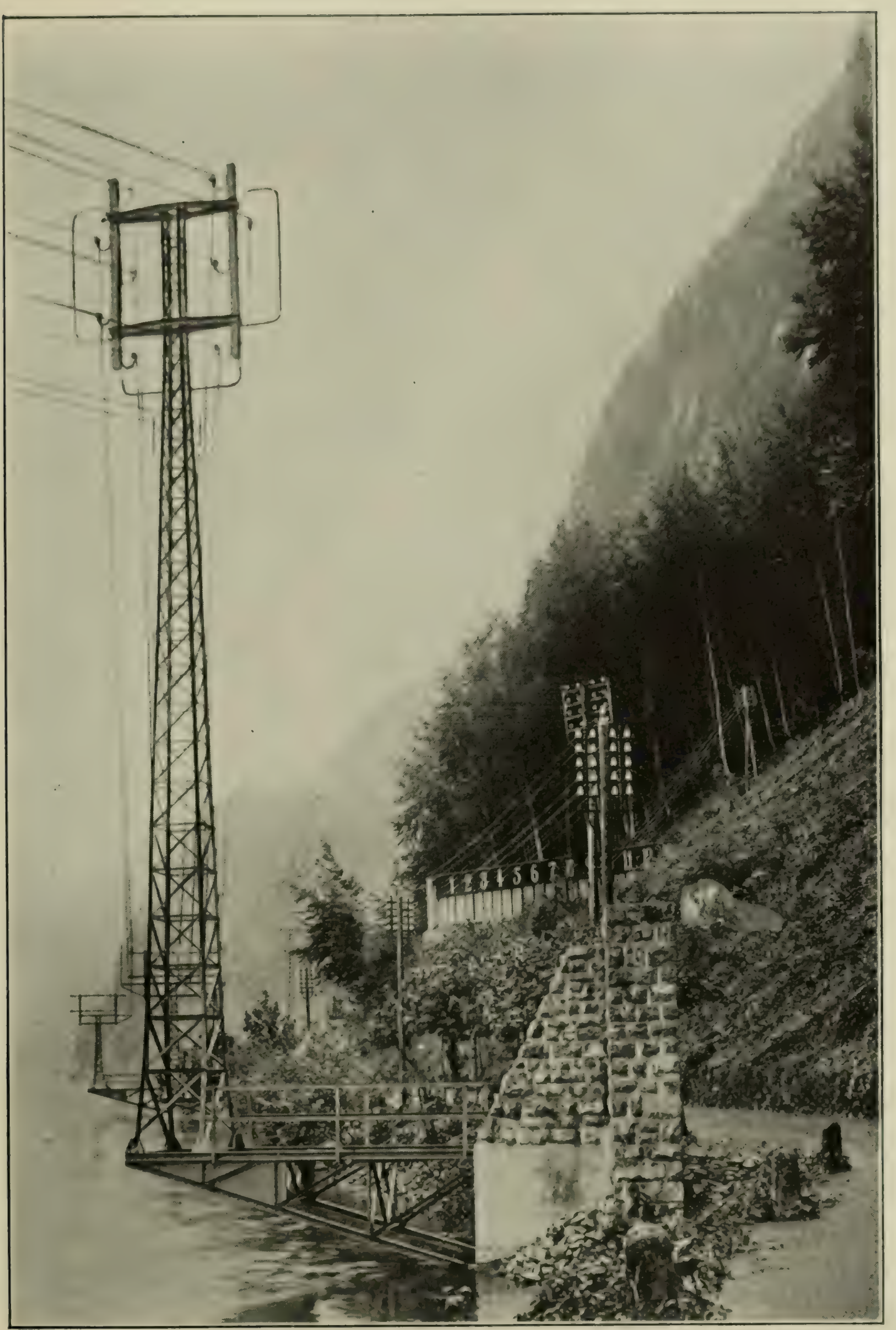
The transmission tower used most extensively in America up to the present time is the four-legged tower made of four angle-iron legs, braced with angle irons or flat bars, diagonal bracing being frequently made of rods. The arms for carrying the insulators may be of structural steel or wood.

A novel method for supporting a transmission tower is found in connection with the 27,000-volt lines of the Lucerne, Switzerland, transmission system. The towers are about 45 feet high, measured from the ground to the top of the lower insulators, which latter are mounted on vertical oak members carried by transverse channels. They are fastened to galvanized-iron pins by means of hemp, linseed oil, and shellac. To prevent a line from dropping to the ground guard angles are provided. Owing to adverse conditions several of the towers had to be placed on cantilever constructions overhanging the lake. For this purpose the cantilever structures had to be imbedded in heavy concrete blocks in order to protect the cantilever and the tower from boulders rolling down the mountain slope; heavy masonry abutments were placed on top of the concrete block; a passage is provided to reach the tower. The total length of the cantilever is 30 feet, while the spacing of the towers is 400 feet.

In laying out a transmission line it is of foremost importance to determine upon the most economical span; that is to say, after the size of conductor has been calculated, not omitting the line loss, the next step is to ascertain the proper spacing. The material used for conductors is copper, hard or soft-drawn, aluminium and steel; all are used in cable form, while a solid conductor of copper is sometimes used. Hard-drawn copper is mostly used as it has an ultimate tensile strength of 60,000 pounds per square inch, while that of soft-drawn copper is only 30,000 pounds. The resistance of the former is 5 per cent greater than that of the latter. Aluminium has a tensile strength of about 28,000 pounds per square inch, while steel varies greatly, averaging 100,000 pounds. Comparing the specific gravities of aluminium and copper, the latter is about 3.3 times as great, so that for cables of equal length and resistance, the copper cable is twice as heavy as the aluminium. As the tensile strength is only about 28,000 pounds per square inch, aluminium wires must be used only in the form of cables. For equivalent conditions the diameter of an aluminium cable is 1.28 times that of copper, while the cross-sectional area is about 1.65 times larger, because the conductivity of aluminium is only 63 per cent of that of copper. Aluminium cables present a larger surface to the wind and also for the formation of ice. The advantages secured in the use of aluminium are, it is cheaper than copper and light in weight, which in turn reduces the cost of the line construction. Owing to the high coefficient of expansion, aluminium wires must be strung in spring or fall.

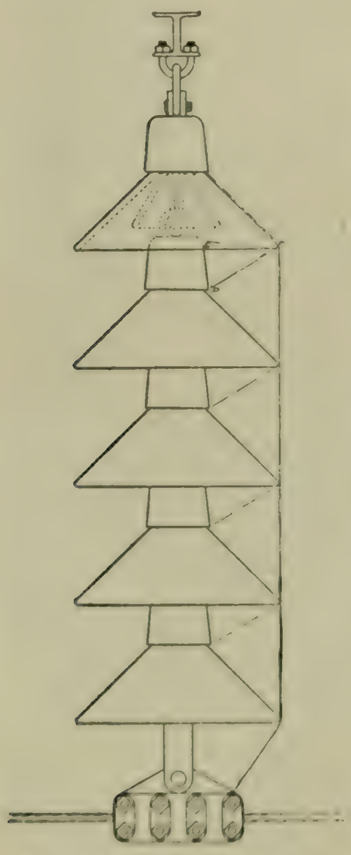
According to the law of transformation, the higher the voltage the smaller the current for a given amount of power. So far as the transmission line itself is concerned the highest voltage which can be produced commercially is the most desirable. A small current on a line means that the size of the conductor can be reduced until the mechanical strength predominates. The use of high voltage reduces the line drop, losses in transmission, and gives better regulation.

The essential factors for calculating the size of line conductors are: the load to be transmitted, the voltage desired at the receiving end, the permissible loss of energy in transmission; the frequency, spacing of wires, and length of transmission line. In calculating the size of a transmission conductor it is poor policy to use a larger conductor than is absolutely necessary. This fact is well illustrated by the law developed by Lord Kelvin. The usual way of stating it is: "The most economical area will be that for which the annual interest on the capital outlay equals the annual cost of the energy wasted." A more precise statement of the same proposition is given by Gisbert Kapp: "The most economical area of a conductor is that for which the annual cost of the energy wasted is equal to the interest on that portion of the capital outlay which can be considered to be proportional to the weight of the metal used."



27,000-VOLT TRANSMISSION LINE AND TOWERS SUPPORTED ON CANTILEVERS, LUZERNE, SWITZERLAND.

The spacing of the conductors depends upon the voltage and the length of spans. It varies from 24 to 96 inches. The increase in spacing increases the inductive drop and also the line loss. The following approximate distances are observed: for voltages from 5,000 to 10,000, 24 to 36 inches; for 10,000 to 30,000, 36 to 60 inches; for 30,000 to 60,000, 60 to 84 inches; for 60,000 to 100,000, 84 to 96 inches.

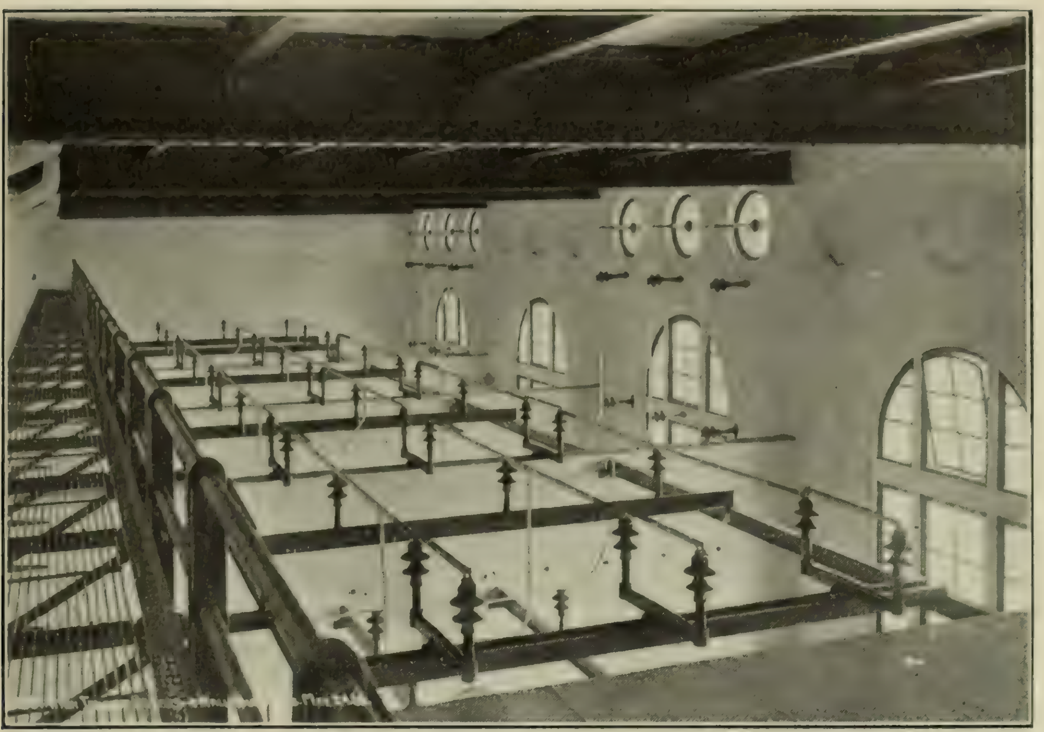


SUSPENDED INSULATOR.
Showing progressive breaking down between beginning of leakage and maximum arc.

With high-tension transmission systems multi-petticoat porcelain insulators are extensively used, and with voltages above 60,000 the link insulator is employed. The former is carried on pins, the latter is suspended. The petticoat types are made in several sections cemented together in the manufacture, and in exceptionally large sizes they are frequently cemented in the field. When this is done care must be exercised to prevent the cement from being chilled while setting; the cement mixture must be a fine rich mortar free from impurities. Besides the electrical stresses the insulators must be strong enough to withstand the mechanical stress imposed on them by the span.

The reason for using suspended insulators is largely a matter of cost, since it is entirely possible to make porcelain insulators of the petticoat type of sufficient size to operate successfully on any voltage, but the extreme height and diameter of any pin-type insulator necessary for 100,000 and 150,000-volt transmissions makes the use of that type prohibitive. The suspended type consists of a number of discs linked together by iron rods or short pieces of cable. Each disc represents a certain amount of voltage, usually about 20,000 to 25,000 volts. One of the first transmission systems installed in which the suspended type of insulator was used is that of the Muskegon Grand Rapids Power Co. The diameter of a disc is about 10 inches, and the rated voltage which each link will withstand is 25,000, although the links are over when wet at approximately 60,000 volts each.

Where high tension wires leave or enter a building the outlet must be protected against the weather. This is accomplished by



HIGH-TENSION BUS BARS AND OUTGOING FEEDERS. DISTRIBUTING STATION OF THE ONTARIO POWER CO.

either building a hood over the wall opening or by inserting insulating bushings in the wall. Another method is to lead the conductor through a hole in the glass plate; the hole being about ¼ to ⅜ inch larger than the conductor. Insulators are placed on both sides of the glass plate so that the section of the conductor passing through the wall is always taut. In Western plants and on the Pacific coast we frequently find an 18 to 20-inch tile pipe for wall outlets provided with a pierced glass plate cover. The tile pipes and bushings used for wall outlets must be set on a slant so that collected moisture can drain off outdoors.

SUB-STATIONS.

Sub-stations or receiving stations are designed to act as distributing centres of the electrical current. They are as a rule located as near as possible to the centre of gravity of the system of distribution. This cannot always be done, however, as the demands on a station vary in certain sections during the different seasons, particularly in street-railway operation. In many cases, to help out in such instances, portable sub-stations are transported to the centres of increased demand and remain until the load on the line can be taken care of by the sub-station proper.

One of the most important elements in modern sub-stations is the transformers for stepping-down the high voltage to that which is desired for local distribution. Transformers are either single-

ABOVE, TRANSFORMER STATION AND LIGHTNING ARRESTER HOUSE, HIRSCHAU-MUNICH 50,000 VOLT TRANSMISSION SYSTEM. BELOW, STEP DOWN TRANSFORMER STATION 50,000-11,000 VOLTS, LOMAZZO, ITALY.

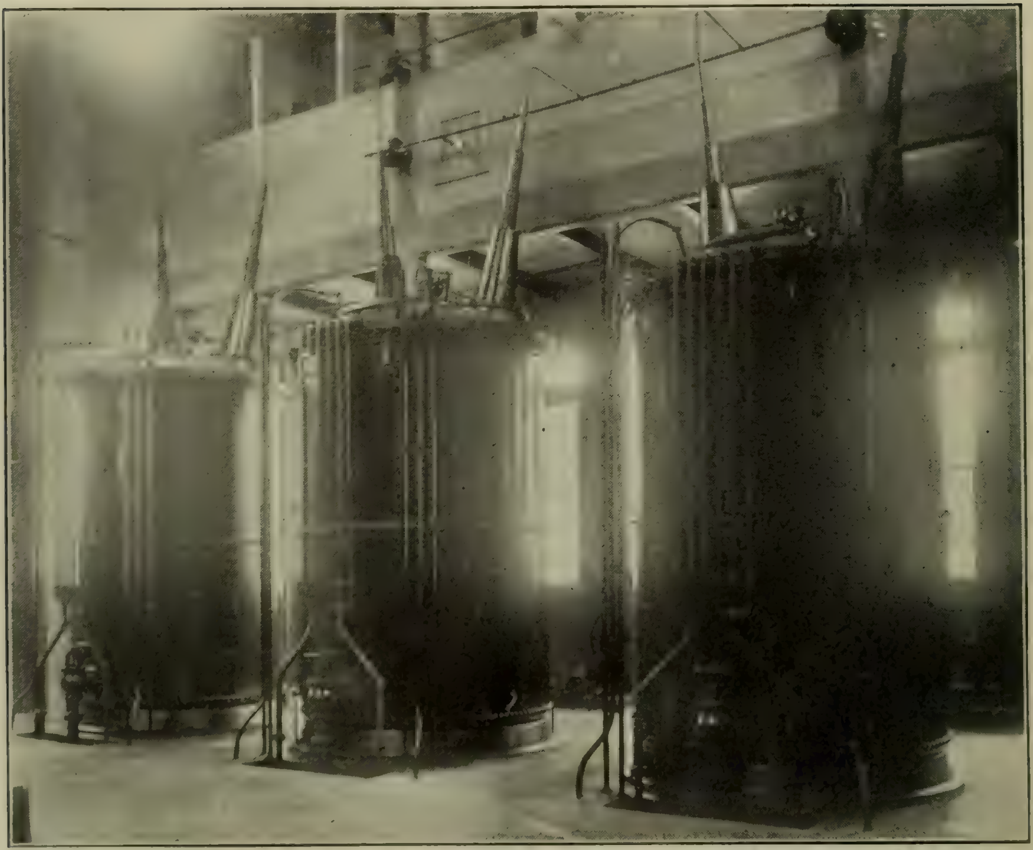
phase or three-phase and shell or core type. The latter is more extensively used abroad and made three-phase. In America besides the core type the shell type is widely known, but chiefly in single-phase design. The advantage of the three-phase transformer is greater compactness and lighter weight, resulting in a considerable saving in first cost of transformer itself, and a saving of about 30 per cent in floor space. The connections with the transformers are simpler and fewer in number than in three single-phase units. The method of winding and insulating is practically the same as in the single-phase transformers.

SUB-STATION OF GREAT NORTHERN POWER COMPANY, DULUTH, MINN.

Aside from the reliability and safety of operation of a transformer the most important electrical features are the efficiency and the regulation. Although good regulation and high efficiency are always to be desired, the relative importance of the two is determined by the local conditions under which the transformer is to operate. Where power is expensive or is used at short intervals only, the efficiency of the transformer especially at light load is of great importance, but where the power is cheap the efficiency as a rule is not such an important factor.

On account of the low cost of power and the double transformation of the potential necessary, the important feature of transformers designed for use on high-voltage circuits is the regulation, and not the efficiency.

In large transformers for long-distance transmission, close regu-



WESTINGHOUSE 3,750-KILOWATT SINGLE-PHASE 100,000—6,600 VOLT 60-CYCLE TRANSFORMERS, GRAND RAPIDS & MUSKEGON POWER CO.

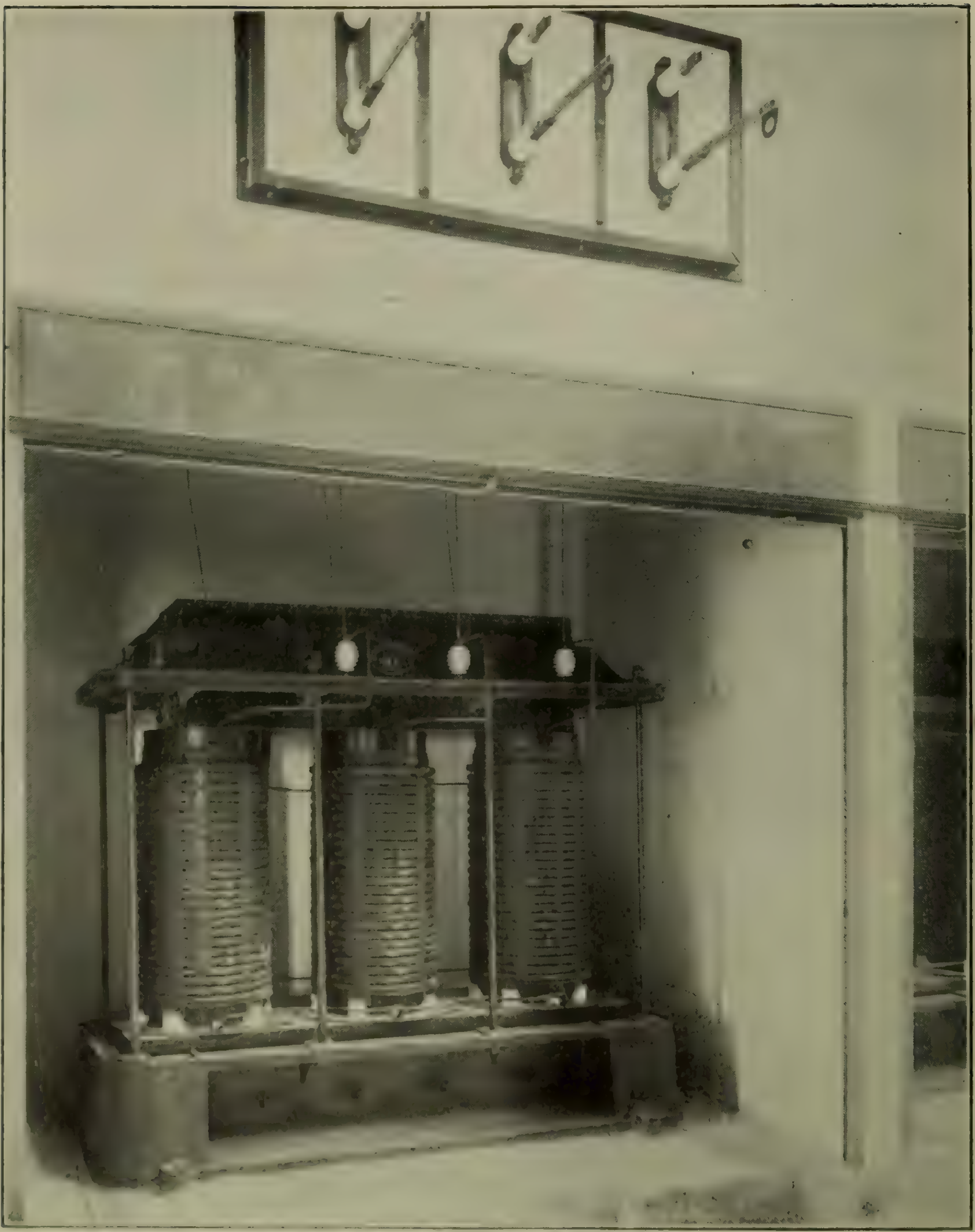
lation is of even greater importance than in ordinary small transformers for lighting circuits, as the drop in the line is of considerable magnitude and with raising and lowering transformers the transformer drop occurs twice between the generator and the load. The drop is generally increased when the power factor of the load falls below unity, is is usual in power work. The regulation of a transformer depends upon the resistance drop and the inductive drop within it. The former is fixed by the amount of copper loss at full load, the latter by the number of turns in the winding and the relative position of the coils and the space between them.

The efficiency of transformers depends on the losses, which are of two kinds, viz.: iron and copper. The former is due to magnetic reversals in the iron and is practically constant for all loads. The copper loss results from the passage of current through the conductor, and is very low for high efficiency at full load. In general, it may be stated that the efficiency of transformers is from 97 to 98.5 per cent.

Transformers are connected in a variety of ways for transmission work: single-phase, two-phase, three-phase delta, three-phase star, three-phase T, three-phase V, two-phase-three-phase, three-phase-star, and delta. These connections give equal voltage across any leg. To go further into detail with reference to the different connections would be out of place here.

As it is necessary to cool the transformers to give a uniform efficiency, either the circulation of oil or air may be adopted. Oil-cooled transformers are most extensively used, for the reason that oil is a better heat-conducting medium than air; besides, oil preserves the insulation, keeping it soft and pliable, and prevents oxidation by air. Consequently the use of oil maintains a uniform core loss and a superior insulation. The oil in the transformer is cooled either by natural gravity circulation or by means of submerged coils through which water is circulated. Oil-insulated water-cooled transformers are built for practically unlimited capacities and voltages. About the

250 KILOWATT 6,000—130 VOLT FORCED-DRAFT COOLED TRANSFORMERS, CASTELNUOVO-VALDARNO PLANT, ITALY.

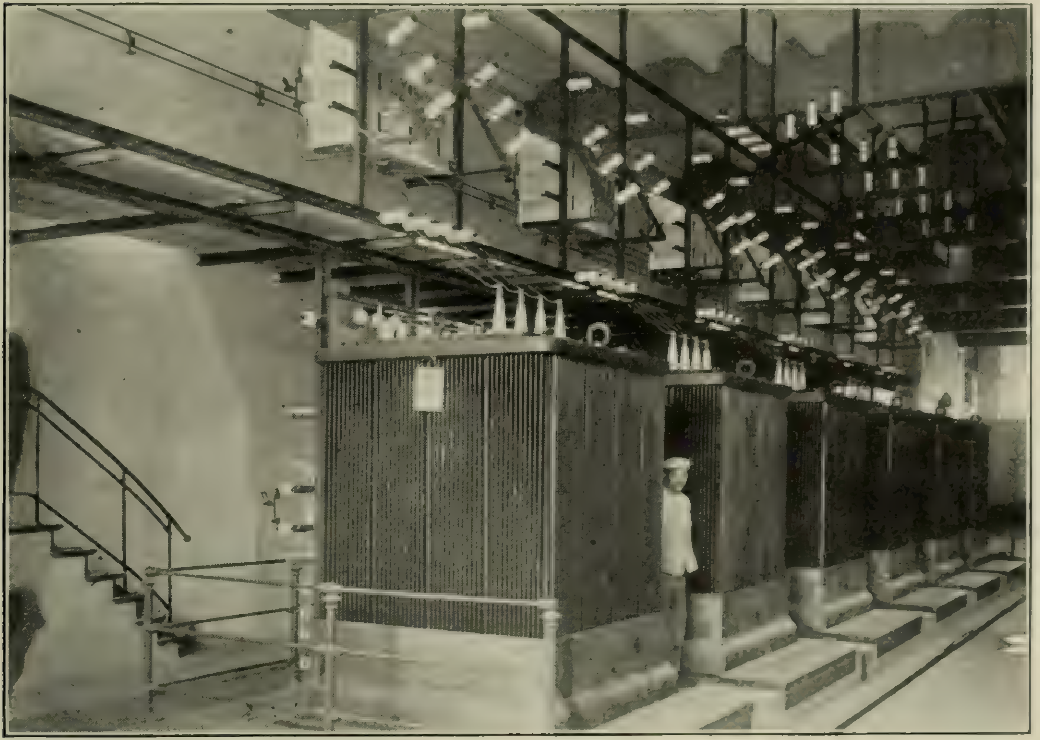


ALIOTH 5,000-KILOWATT OPEN-TYPE AIR-BLAST TRANSFORMER, LOMAZZO SUB-STATION, ITALY.

only places where they can not be used are in sections where water is extremely scarce or where the storage of large quantities of oil is objectionable. The method of cooling the transformers by forced oil-circulation has the advantage of doing away with the cooling coils in the transformers. However, a separate cooling device has to be installed on the principle of a cooling pond or surface condenser.

In the early type of transformers the cooling was done by natural air draft or by forced draft, and the latter method is still much in vogue. The cores of the transformers are encased and the air is forced through by means of a blower.

Air-blast transformers are used where cleanliness, limited floor space and freedom from storage of large quantities of oil are features. It is for these reasons that they are principally used in large cities. They are built in all capacities and frequencies and, according to American practice, up to and including 33,000 volts. This limitation in voltage is due to the excessive amount of insulation required for higher voltages. It is possible, however, to operate air-blast transformers on circuits up to and sincluding 50,000 volts if the circuit is Y-connected with the neutral solidly and permanently grounded.



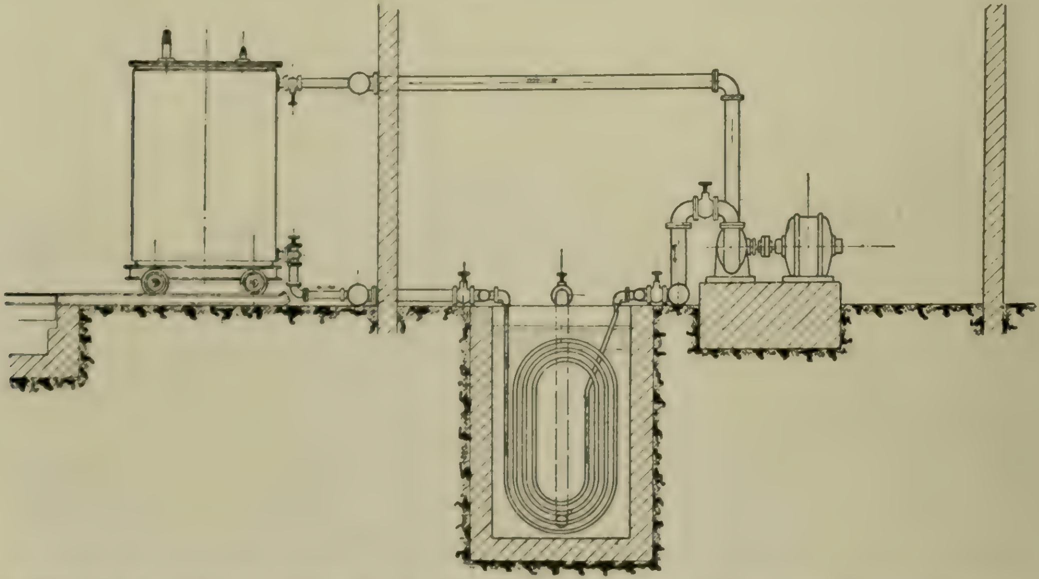
SIEMENS-SCHUCKERT AIR-BLAST TRANSFORMER, KYKELSRUD PLANT, NORWAY.

In recent Swiss and Italian practice, in connection with 50,000-volt transmission systems, a number of air-blast transformers are in successful operation without the customary casing. The cores are placed in masonry compartments provided with rolling shutters, and the air is forced into the compartment from beneath. The advantage of this setting is ready inspection without removing the core from its compartment.

All transformers should be so installed that they may be readily repaired on the spot or may be removed to the repair shop, usually adjacent to the transformer room.

It is the general practice to place oil-cooled transformers in closed compartments, and the transformers are provided with small wheels by means of which they may be rolled on a truck and removed to the repair shop.

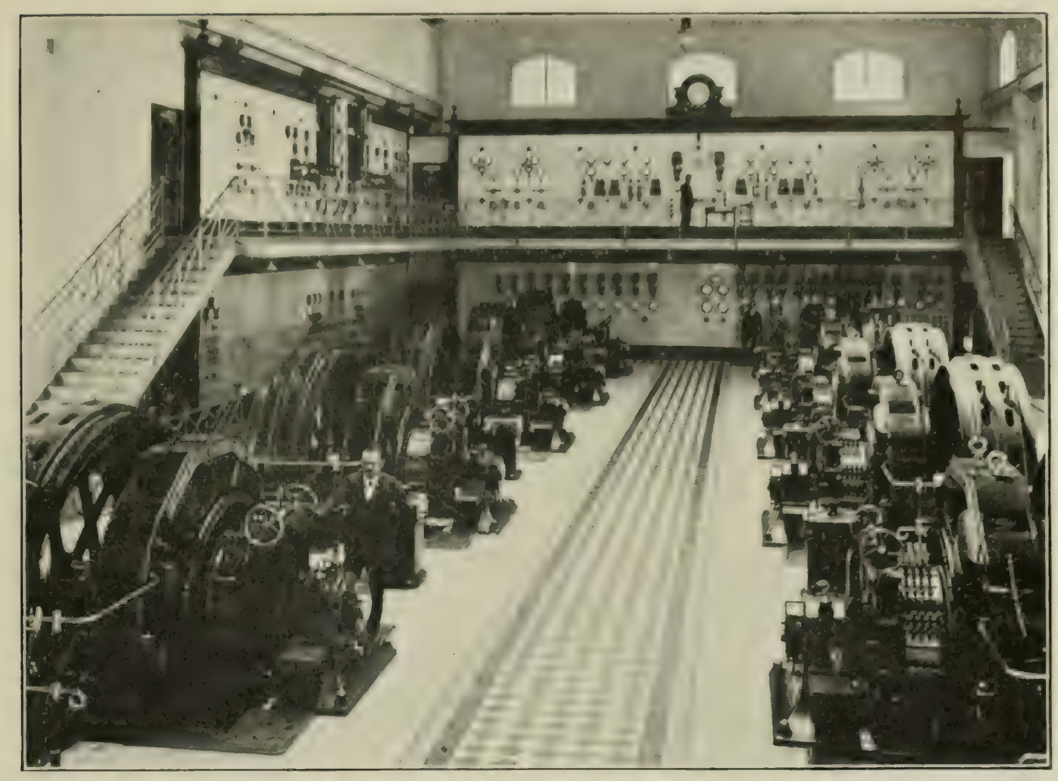
For transforming alternating current into direct current, rotary converters are installed. They may be connected to alternating mains and operate as simple synchronous motors, or connected to direct-current mains and operated as simple direct-current motors.



METHOD OF COOLING CIRCULATION WATER FOR 6,750 KILOWATT 6600—66000 VOLT THREE-PHASE SIEMENS-SCHUCKERT TRANSFORMERS, MOLINAR, SPAIN.

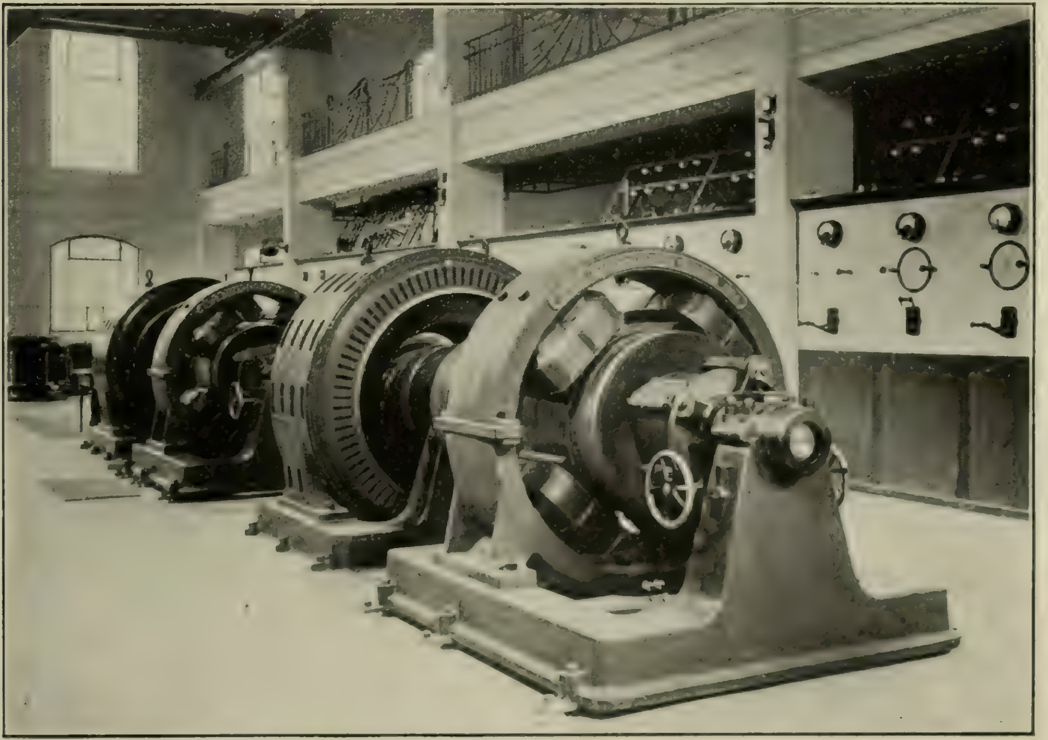
There are a number of other electrical and mechanical connections which can be applied, but the main purpose is to serve as a means of converting from alternating to direct current. Rotary convertors, in order to give the best service, must run in exact synchronism with the supply current, but it frequently occurs that the speed of the generator is not exactly uniform; and in such cases, the rotary will tend to follow the fluctuations of the generator speed, resulting in a surging action of the rotary armature alternately above and below synchronism. This is commonly known as "hunting," and often assumes disastrous proportions when no provisions are made for counteracting this effect.

When the line voltage is not too high a motor-generator set may be used in the place of a rotary convertor; the motor of the set may be directly connected to the line, thus eliminating transformers. The advantages of using a motor-generator set are, that no synchronizing apparatus is necessary, the voltage of the generator bears no relation to that of the supply, and it may be adjusted through a wide variation. The disturbance known as hunting does not exist, and when an induction motor is used as a driver no skilled attendants are necessary. The disadvantages are, that the efficiency is from 4 to 7



TYPICAL CONTINENTAL MOTOR-GENERATOR SUB-STATION, VIENNA STREET-RAILWAY SYSTEM.

per cent less than that of the transformer-convertor set, and the cost is higher. Another machine sometimes used in sub-stations is the frequency changer. It differs from the motor-generator set in the fol-



INTERIOR OF MOTOR-GENERATOR SUB-STATION, STEGHOF, SWITZERLAND.

lowing respects: the driving motor must be a synchronous motor and the generator an alternating-current machine. The generator has more or less poles than the motor, depending upon the frequency desired. Sometimes an induction motor is substituted for the generator and made to rotate above or below its rated speed. The alternating-current line is connected to the rotor of the motor, and when the rotor operates above its rated speed, the frequency is increased; when below, the frequency is decreased.

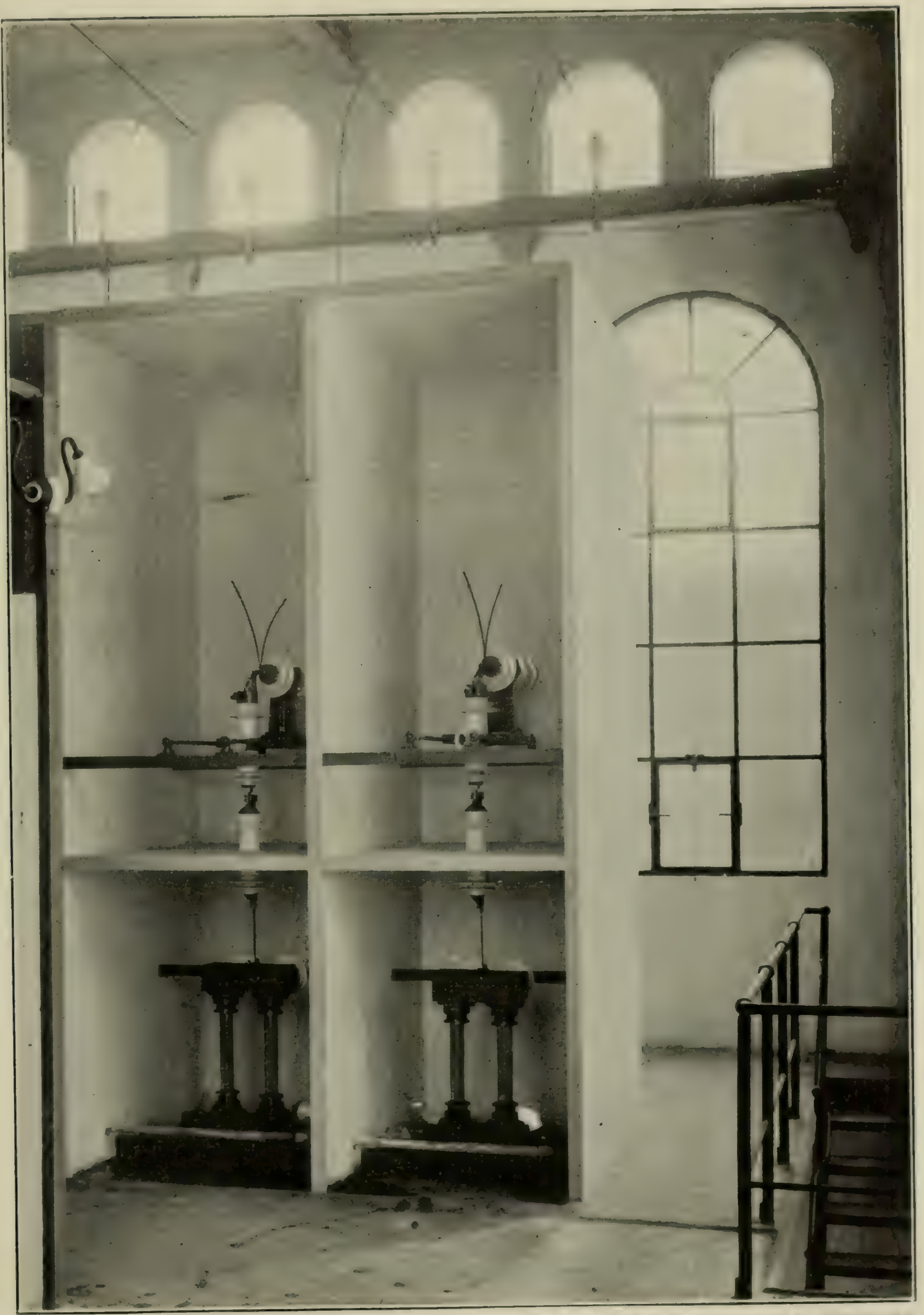
The switchgear of a sub-station is similar to that of the main generating station, and therefore need not be further discussed, as this has already been treated in the preceding article.

Line Protection.

To guard against interruption of service of the generating plant the generating apparatus must be protected, particularly against atmospheric discharges. This is done by providing the transmission system with lightning arresters or some form of grounding device. The function of this is to act as a relief vent. Various sorts of disturbances, (particularly where the transmission line runs through sections of country of different altitude), the chief of which is lightning, cause surges and oscillations in the circuit of such frequencies and high potentials as will endanger the apparatus of the generating plant, sub-station, or probably both.

The lightning arrester must permit sufficient freedom of escape of a charge from transmission lines to limit their potential to a safe value. To do this, a vent is required which will permit a very large flow of current when the potential is above a certain value, but which will suppress this flow of current quickly, quietly, and completely as soon as the potential has assumed a normal value. In other words, the arrester must permit the escape of the abnormal surge, but should preferably take no current whatever and consequently cause no additional disturbance or drop in voltage.

In general, a lightning arrester is made up of three elements, viz., an air-gap, a current-limiting element, and an arc-suppressing device. Two of these elements are always present, and usually the other is combined in some form with the other two. The air-gap holds the voltage ordinarily, but is broken over by any great excess potential, thus permitting current to flow. The current-limiting element usually appears in the form of a series resistance of some kind which limits the power current to a reasonable value. The arc-suppressing device is provided by some modification of an air-gap, and may consist of a magnetic blow-out, a mechanical arrangement by which the length of the gap is increased until the arc breaks (horn type), or non-



OERLIKON HORN LIGHTNING ARRESTERS WITH WATER-FLOW GROUNDERS, STEGHOF, SWITZERLAND.

arcing gaps consisting of a number of small cylinders with the proper spacing between them. The horn-gap is extensively used in Europe, while the multi-gap is used in America, and of late years the former is also very extensively used in connection with fluid arresters.

There are two kinds of fluid arresters used in America. In one the components are submerged in oil in a steel tank and known as an aluminium arrester. In the other the components are encased in an empty porcelain jar, and this is known as the electrolytic arrester. The principle of both is practically the same. It consists of a series of concentric aluminum pans placed one above the other, separated by an electrolite usually of borax solution.

In the aluminium arrester each cell is designed to operate normally at 300 volts, with a very small leakage current and with a permanent critical voltage of 420 volts, that is, the voltage at which the film opens and allows a free and heavy discharge, and a permanent critical value is thus 40 per cent above the normal operating voltage. Sufficient cells are placed in series on circuits of any given voltage to allow a normal voltage of 300 per cell. The arresters are connected permanently between line and ground and a multi-gap or horn-gap set at suitable value above line potential is inserted in series, and prevents the arrester from being subjected continuously to the line voltage. In this way leakage is prevented during normal operation and a longer life is assured.

Water-flow grounders have of late years very frequently been used on the continent of Europe, where they originated, and we find today a great number of types there. However, in America their use has not been advocated for the reason that the assumption of the failure of water supply points out, that the apparatus is inefficient. This objection is not quite justified, as the water may be drawn from the same supply from which the main turbines are fed, and as substations are usually located near a city, water from the city mains can be used. It is the practice in continental Europe to make use of the water which circulates through the cooling coils of the oil-transformers. Further, water from springs is oftentimes available. Water-flow grounders allow a continuous leakage, and one form of apparatus installed in connection with a 50,000-volt transmission system in Italy consists of a nozzle or jet of water (from a spring) playing against a baffle plate connected to the line. The stream of water is 3/8 inch in diameter, 28 inches long, and allows a leakage of 0.1 ampere. These are installed in addition to horn-gaps and choke coils to take care of light surges in a line and to maintain a uniform line pressure.

THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington Emerson.

I. THE FIRST PRINCIPLE: CLEARLY DEFINED IDEALS.

Mr. Emerson's current series began in our June issue. The introductory article was a brilliant demonstration, from historic examples, of the power of certain principles of efficiency. His second paper showed the unsuitability of the ordinary organization for the introduction of these efficiency principles, and indicated the nature of the changes necessary to permit their application. He has now reached the "Twelve Principles" themselves, and will take up each one individually, beginning in this issue with "The First Principle: Clearly Defined Ideals."—THE EDITORS.

ASSUMING an organization adapted to their application, it will be found that efficiency principles, although all interrelated, all necessary to each other for highest results, nevertheless stand in a logical sequence.

The first principle is *a clearly defined ideal.*

In the earlier days of American manufacturing and transportation development, a century ago, a bright young journeyman who started out to manufacture some special line was very definitely aware of what he intended to make and how the work was to be done. He knew what he wanted. At the present time, in large plants men succeed to authority by transfer or by promotion and are very often without definite conceptions of the purposes for which the plant is working. Workers and foremen at the lower end of line organizations are so far from "The Little Father" or from the "Big Stick" who dictates all policies, who alone is responsible for organization, for delegation of power, and for supervision, that they are driven to create minor ideals and inspirations of their own, these being often at variance with the ideals of those above them. If all the ideals animating all the organization from top to bottom could be lined up so as to pull in the same straight line, the resultant would be a very powerful effort; but when these ideals pull in diverse directions, the resultant force may be insignificantly positive—may, in fact, be negative.

This condition of subsidiary deleterious and conflicting ideals is very common in all American plants, as well as great vagueness and uncertainty as to the major ideal, even among the higher officials, as we shall try to show by various examples which could be duplicated by every experienced manager in the country.

A handy man in a railroad repair shop examined cylinders for cracks. These could sometimes be patched, but in other cases a new cylinder had to be ordered. A patch may cost $30, a new cylinder $600. The handy man swelled with pride when his recommendation for a new cylinder was heeded. He boasted to his wife and fellows of the confidence placed in him and the importance of his work. When in doubt, he reported always in favor of a new cylinder; and it was easier to accept his recommendation than to institute a separate revisional examination to be made by a man scarcely better qualified. The ideals of economy and promptness were submerged, and the conflicting ideal of individual aggrandizement substituted.

A large plant was filled with machinery for turning out work. Some of these machines were automatic and some hand-operated. The automatic had been introduced to lessen expenses and delays. The superintendent of the department was an ardent patriot and churchman; not a man was employed by him who was not recruited from his own nationality and church. He had installed piece rates, singularly inappropriate, since volume of work fluctuated suddenly between wide limits. When work fell off, instead of doing it all on the automatics, he shut these down, and had it all done by hand so as to give employment to his piece workers. His ideals were not "*best product in shortest time at least expense,*" but "*largest amount of employment and reward to fellow-countrymen and co-religionists.*" This superintendent being unsupplied with ideals by the management, had created his own.

In another plant twenty-four men were working in the tool room. This was an excessive force, and the specialist in charge of tools allowed it gradually to shrink through resignations to eighteen men. Suddenly six new men reported for duty in the tool room, engaged by the general foreman. When the specialist interviewed him on the subject he stated: "My allowance for tool room is twenty-four men. If I get along without this number my allowance may be curtailed. Later when I need the men I may not be able to secure them. I propose to maintain the allowance whether there is work or not." It took a long time to convince this foreman:—

First, that twenty-four men were not needed.

Second, that if scheduled work made fifty men necessary he could have them.

Distorted ideals placed him in antagonism to the main purpose of the management.

In another plant, a general superintendent was very averse to any reduction of men below one thousand. He was anxious to turn out more work, was willing to curtail hours of the thousand employed, but to fall below one thousand, even though they voluntarily dropped out, seemed to him to be lowering his own rank since he had worked for years to reach the position of superintendency over a thousand men. Economy, efficiency, were all waived on account of a perverse ideal—personal pride.

The general superintendent of a plant employing twelve thousand mechanics was firmly convinced that the only way to turn out a large volume of work was to employ more men. He seemed to think that men could be piled into one side of the balance scale and volume of work into the other and that men would pull up the work by their gross weight. On one occasion he sent out an order that economy was not the object, but the production of output, and that the force was to be increased to the maximum. He ran up expenses $500,000 in five months and raised his unit costs far above what they had been, far above those of his competitors, far above what they retreated to when he was relieved of authority. A false numerical ideal worked at contrary purposes to true efficiency ideals.

The president of a great industrial corporation authorized standard-practice policies, then entered into contracts with clients on the basis of material, direct labor, and a percentage on direct labor. When it was pointed out to him that increased efficiency would mean fewer hours of direct labor, therefore less pay and less percentage for the same work, he promptly solved the difficulty by relieving the standard-practice advisor from the duty of offering further unpalatable advice, and by forbidding the application of efficiency methods to the shop in question.

In the early days of railroad construction all over the world, false conceptions and ideals greatly increased cost and left a legacy of inefficiency that centuries may not be long enough to obliterate.

The British engineers set up such high standards of grade, curvature, and double tracking, together with such low standards of clearance, as to double the initial cost of all British roads and curtail forever their capacity.

It is told of King Louis I of Bavaria that when he took his initial ride on a newly constructed rail line in his kingdom, he expressed great disappointment that there was no tunnel, so the line was relocated and made to run through a hill.

Emperor Nicholas of Russia when deferentially asked by his engineers how the line was to be located between St. Petersburg and Moskow, took a ruler and pencil and ruled straight lines between the two cities. "That is the location, gentlemen!" It cost $337,000 a mile. Americans feel like smiling scoffingly at these mistakes, but was this arbitrary action any worse than that of a Secretary of the Navy who, without investigation and in spite of remonstrance by the naval board of construction, ordered the Texas built exactly according to the discordant purchased plans for two different vessels? No wonder the Texas was always a monstrosity!

What also shall we think of that American transcontinental road which having a water level between two points, 384 miles apart, deliberately abandoned the water level and put in 2,500 feet of mountain climbing and as many of descent between the same points, the officials after all failing to secure from a little western city the bonus for which they had sacrificed good location for all time.

In all these instances, from handy man with cracked cylinder to king, emperor, or knave ruling a railroad location, there is a definite ideal, however bad, consistently pursued; and when these ideals stand in dependent sequence, the result becomes exceedingly costly. The handy man orders a $600 cylinder instead of a $30 patch; his foreman, wishing to employ as many of his church members as possible, has the cylinder made on an inferior machine, with high piece rates; the general foreman fills the tool room with unnecessary men who become busy doing useless work at heavy expense for materials and overhead expense; the shop superintendent is content as he sees the men under him pass the one-thousand mark and joyfully acquiesces in the general superintendent's order to add fifty per cent to the force. Under this sequence, the making of an unnecessary $600 cylinder becomes almost a necessity and the handy man is promoted on account of his skill as a work provider. The 2,500 feet of mountain grade make many additional locomotives necessary, so there are many more opportunities to make new cylinders instead of patching old ones.

These are examples of the cankering effect of low or lateral ideals, but perhaps even greater loss results from vague ideals and from personal impulse.

At the siege of Sebastopol the officers at dinner in the ward room of a man-of-war were astounded to hear the big siege gun boom several times, with explosions of midshipman laughter afterwards. Each firing of the gun cost $250. Investigation showed that bets were up between the middies as to which one could make a donkey move in the public square, and each was taking a shot in turn—with no damage to the donkey.

An engineer poured onto the ground a gallon of 40-cent oil in order to have the tinsmith solder a leak in a 15-cent can. A railroad track foreman and gang were recently seen burying under some ashes and dirt a 30-foot steel rail. It was less trouble to bury it than to pick it up and place it where it could be saved.

A young engineer in railroad service started out to spend some $750 for photographic apparatus, evidently laboring under the impression that if he only spent money enough he could overcome personal, meteorological, optical, and other limitations to good work.

The superintendent of a plant ordered a large automatic lathe to make crank pins from the solid bar. He had no ideals of his own, but vaguely felt that an automatic lathe ought to do cheaper work. When wire is cut into small screws it is the work that gives value, not the material; but in a crank pin it is the material that costs more than the work, and the cost of waste of new material on the automatic was greater than the total cost of scrap material, drop-forging, and turning by a boy under the old method.

The American mind is alert; men as individuals have been successful in proportion to their initiative; they have made great individual successes and also great individual failures.

It is not an accident that an American reporter was sent to find Livingston and that an American explorer forced his way to the North Pole. This reckless confidence in impulses, this reliance on individual initiative, is responsible for many failures and even if wild advice is not always followed, it is alarming that it can be so confidently offered.

At the time of the planning of the Grand Trunk Pacific Ry. a very brilliant young surveyor and railroad engineer wrote a thesis, urging that the gauge of this new line be made 30 feet, freight cars be made large enough to handle 1,000 tons, and all the buildings in the new villages, town and cities be erected in standard cement sections. Happily this young man's power was not commensurate with his imagination, but it is not always so. Not only do individuals make tremendous blunders, but corporate bodies make greater ones, because, not being composed of specialists, they are not able to curb the initiative of a strong-willed leader. As a consequence, clearly defined ideals are lacking and this relative lack will have to be pointed out along general lines, using for illustration the seven wonders of the ancient world, the seven wonders of modern times, and in comparison with them seven great American enterprises.

There were seven ancient wonders of the world, each one of them a great work, nobly carried out. Even after the lapse of centuries, moderns of alien races can recognize and sympathize with the ideals that inspired these wonders. One of the tests of a definite ideal is that we can apprehend it even if we cannot always sympathize.

The oldest wonder-work of man is Egyptian—the great pyramid—at once a tomb and an astronomical instrument. The last ancient wonder was also Egyptian, the Pharos light house at Alexandria to direct the floating commerce of the old world to this great city. One of the modern wonder works is also Egyptian, the Suez Canal, so that through four millenniums Egypt has done a full share.

We can sympathize with the desire to have the largest and highest tomb ever constructed so that the bodies of king and of queen, preserved against decay, may lie in royal state until the time of resurrection. We can sympathize with the conception of the great light house, built by King Ptolemy Philadelphos—even with the trick of the architect Sostratos, who engraved his own name in the solid stone, but hid it by a layer of perishable cement in which he engraved the king's name.

Of the remaining five ancient wonders one was the hanging gardens of Babylon—a peculiarly appropriate glorification of irrigated tropical vegetation which has always been able to support the densest population, a power that may in time turn the tide of civilization backward from Canada, Northern Europe and Northern Asia, back from Argentine to tropical America, to tropical islands. The other four wonders were Greek, one of them the temple of Diana at Ephesus, one the tomb of King Mausolus erected by his widow, and two of them statues, the Colossus of Rhodes, spanning with outstretched legs the entrance to the harbor, and the master work of Pheidias, the gold-ivory statue of Jupiter at Olympia. There was faith or hope or love or beauty or civic pride in each of these seven wonders.

Of the seven modern wonder works of the world, not one is American. One of them, 400 years old, has its inspiration in religion—St. Peters at Rome, the largest church ever built; the second, 100 years old, is the greatest triumphal arch ever erected, commemorating the victories of the great conquerer Napoleon I; the other five are modern engineering works. It is typical of the changed ideal of the ages that only one of the ancient wonders was utilitarian, and only one of the modern wonders is religious, five being very distinctly utilitarian; yet noble ideals gave them all birth.

Of the utilitarian works the Suez Canal easily comes first. It shortens the sea route from northern Europe to the Orient by 5,000 miles, between certain ports more than half. The canal was begun in 1859, estimated to cost $30,000,000 and to be finished in 1864. Its actual cost was $80,000,000 and it was opened in 1869. The ideal was realized, but none of the other eleven efficiency principles was thoroughly applied, most of them not at all; hence both the double time and trebled cost.

The next great engineering work was also French, the Eiffel tower, rising 1,000 feet into the air, at once the highest structure erected by man and the prototype of modern American steel construction, which as a matter of course followed when passenger elevators or lifts were made practical.

The third great wonder is the Firth of Forth bridge; cantilevers, similar to three pairs of great Eiffel towers, each pair joined at its base, each half stretching out horizontally 900 feet without end support. This bridge is massive in design because wind pressure is more dangerous than train load.

The fourth modern wonder is the St. Gotthard tunnel, 12 miles long, under the Alps. There was a Brenner railroad route over the Austrian Alps; a Mt. Cenis tunnel under the French Alps; but Italy, Switzerland and Germany combined to divert the century-old trade between south and north to a shorter new route, the key to the situation being the long tunnel, more than twice as long as any American railroad tunnel. This enterprise almost failed because the workmen, hygienically neglected, died in great numbers, killed by an intestinal parasite similar to the hookworm. The doctors ascribed the mortality to the work underground. The parasite has recently appeared in the United States, and may prove as serious a scourge as the hookworm.

The seventh and last of the modern wonders are the twin cousin ships, the Lusitania and the Mauretania, subsidized and designed to restore to Great Britain the blue ribbon of the sea. Of these seven wonders one belongs to Italy, one jointly to Italy and Switzerland, three belong to France, and two to Great Britain. An ideal definitely conceived in advance and tenaciously realized is manifest in each, and in most of them other efficiency principles are applied, in some only in embryonic vestiges, in others in advanced form—notably in the two steamers, which as to cost, time of completion, and performance, realized expectations.

With these fourteen wonders, each with its own ideal, we may compare seven great American works of which none is religious, none a monument to beauty, while the utilitarian value of five of them is doubtful.

The Panama Canal, easily the costliest engineering work ever undertaken, is being prosecuted with vigor, and, thanks to the discovery of the yellow-fever mosquito and its suppression, a lock canal will be finished at a cost of about $600,000,000. Of twenty great minds selected by lot, no three would agree as to the ideal back of this great work. Mr. Roosevelt is entitled to speak with more authority than any one else, and his reasons for its building are also those of Goethe —that it was a work that some one would be tempted to undertake, some time, and that the United States was manifestly the proper party.

This is vague and uninspiring. The canal, in times of piping peace, when a navy is wanted for minor police duties only, ought indeed to lessen the need for a double fleet, one in each ocean; but those who favor a strong American navy, capable of holding its own against such a combination as Great Britain and Japan, scoff at the canal as a substitute for a strong navy. They know full well that in case of war with strong maritime powers either entrance to the canal could be made exceedingly dangerous by floating mines, by submarines, by aeroplanes; that it might be easy to destroy the canal itself either by damaging the locks, damaging the dam of the Chagres River, or sinking some vessel in the canal. If, for self-protection, it is imperative for the United States to maintain maritime strength both in the Atlantic and Pacific, it is not safe to risk the national honor and supremacy on any such device as a lock canal* trusting that it will work like a watch in war time.

The next in rank of great American engineering works are the new railroad terminals in the city of New York to cost about $300,000,000.

There are engineers who consider big passenger terminals a survival of the time when English coaches started from some central hostelry. Central terminals are perhaps a convenience to through passengers, with trunks; never to local passengers without trunks.

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* From a military point of view, a tide-level canal would be in no better case. Its tremendous cuts, many protective works to control entering streams, tide locks at the Pacific, and long narrow channels would make it as vulnerable as the lock canal.—*Ed E. M.*

Passengers with trunks are very few, even in the fast through trains. Is it possible that these great terminals have been built to accommodate the few hundred passengers who have trunks? The 500,000 people who go out to and return from Coney Island on single hot summer holidays have not required great terminals; the million and a half of visitors handled on Chicago day at the Columbian Exposition did not require $100,000,000 terminals; the hundreds of thousands of passengers handled daily at 42d Street subway or at Brooklyn Bridge have not required palatial terminals. In fact, these great crowds would neither gather nor could they be handled if they had to assemble at an initial terminal, and debouch from an arriving terminal, both far from their homes. Passengers want to be picked up at their doors, landed at their doors, like letters; they do not want the plan, now obsolete even in villages, of delivering themselves like letters at the central post-office and collecting themselves like letters from the general delivery or *poste restante*.

Nothing is more convenient than the present plan of checking trunks from house to house in cities far apart, for a charge of one dollar, nothing more convenient than to drop from business office in New York into subway ten minutes before train departure and go to Seattle, Portland, San Francisco or Los Angeles, winter or summer, needing neither hat, top coat, nor umbrella since the traveler is never without cover, and if transfer has to be made it is more comfortable and easier to make it from a Denver train to the Santa Fe flyer at La Junta, Colorado, with its little station, than to make a similar change in a great New York, Chicago, Philadelphia, or Washington terminal. The great problem of city traffic is to secure distribution, to scatter foci, to dissolve congestion. Terminals of necessity create and increase congestion. Physically or financially, the ideals justifying these great terminal expenditures are not startingly apparent. Material and maintenance charges on these great works, if distributed to each incoming and outgoing trunk, or even to each going and coming through passenger, would give a striking modern illustration of Horace's dictum that no artist makes a mountain travail to bring forth a mouse.

The third great American enterprise is the New York barge canal. Railroad men, keenly alert as to its folly, assert that the money to be spent in the barge canal would build, equip, and operate without freight charges a railroad between Buffalo and the Hudson, capable of handling ten times as much freight in the course of a year. A barge canal built by the State seems a roundabout way of curbing and limiting dreaded hypothetical railroad extortions, since the St. Lawrence River and Montreal route more or less fixes export rates from all American ports during the open season of navigation for canal and river.

The fourth great American projected undertaking is the improvement of internal waterways. It is assumed that the railroads are uncontrollable, although a single growl by the Interstate Commerce Commission causes a senseless decline of values in Wall Street. It is assumed by some that internal water transportation, subject to all the vague uncertainties of low water, flood, and frost, can be made so cheap as to bankrupt the railroads, although the Mississippi from St. Louis to the sea, open the year round, is paralleled by dividend-paying railroads. Railroad operation with its chronometer trains 99.97 per cent. reliable between terminals 1,000 miles apart has in this respect realized an exalted and noble ideal not to be undermined and curtailed by the return to obsolescent canals and river highways.

Our fifth great proposed expenditure is for an American Navy. If there had been no Maine there would have been no Spanish war, no war expenditure of one thousand million dollars, no Philippine problem making us an Eastern Asiatic power when we have not yet solved a dozen simple elementary problems at home, such as living wages for sweat-shop workers, lack of employment, civic honesty and cleanliness.

Every battleship five years old is obsolescent. Today and next year's development of flying machines may make every naval vessel as doomed as was chain and mail armor after the invention of gunpowder, as was the sailing corvette after the development of the steamship. Great Britain needs a navy and has kept up to date; has moreover coaling, repair and cable stations, indispensable to its effectiveness; but the value of great war navies to other nations—Germany, France, Russia, Italy, Argentina and the United States—has not yet been demonstrated; and to two of them, it has proved an added calamity in a losing war.

Every one of these five great works commits one of our American besetting industrial sins—over-equipment—due to mistrust of spiritual forces, reliance in material measures. It is almost assumed that if a mistake is gigantic enough it will become praiseworthy.

The sixth and seventh great American works are utilitarian, the subways in New York, and the elevator-served tall buildings everywhere. Even as to these, definite ideals have not been established and followed. Some of the tall buildings sacrifice utility to ornamentation, others are painfully ugly but admirably adapted, while a third class are both ornamental and convenient. As to the subways, in view of the fact that they are an independent system connecting with no other road, it is a pity that they were not made with 6-foot gauge and 12-foot wide double-deck coaches, thus giving 150 per cent. greater seating capacity for the same length of platform and for an insignificantly greater initial expense.

It is not either the right or the privilege of the Efficiency Engineer to set up ideals of morality, goodness, or beauty, or to assume that his ideal of purpose is superior; but he has a right to expect that some definite and tangible ideal will be set up so that at the start its possible incompatability with one or more of the efficiency principles may be pointed out. The ideals underlying British railroad construction are very clear. No grades, no curves, no grade crossings, double tracks, great passenger terminals, and capitalization of all betterments. Although five of these ideals are not compatible with common sense and were not adopted at the start by either practical colonials or Americans, the Efficiency Engineer can accept an estimate of $375,000 a mile, the cost of British railroads, and aid in giving the best result possible for the money, since these ideals are not incompatible with any efficiency principle except common sense.

There is one great American railroad genius, always an idealist, who has risen to the commanding position in the railroad world because he had definite ideals. He states that a railroad company is to be managed to earn dividends, that expenses are by the train mile and receipts are by the ton mile. In twenty years, on these three precepts, he has built up a dominant railroad system. He has developed the country through which his road ran, and lowered rates, because this gave him more ton miles. He has reduced grades and curvatures and used heavy locomotives and long trains because this reduced the cost per train mile. He has reached out for Oriental traffic because this not only gave more ton miles, but equalized traffic, thus lessening ton-mile cost. To each one of the three ideals—dividends, low mile cost, large volume of traffic—each of the other eleven principles could be applied and in unusual measure have been applied by James J. Hill.

Another great railroad executive, J. W. Kendrick, regarded disagreements with labor as consuming time and energy, destructive to peace, loyalty, and harmony, and he therefore resolved to set up a high standard of discipline based on the Fair Deal made attractive by an Efficiency Reward. Not a breath of labor trouble has occurred in six years in the departments to which these principles were applied, and the cost of each item of work has decreased, the standard of excellence has risen, the men have earned more money.

It is, howver, in industrial companies smaller than the great railroads that in a few cases high ideals have been adopted.

The ideals of one company are that its customers shall be treated with absolute fairness, that its employees shall be of higher skill and be better paid than those of neighboring competitors, and that they shall have permanence of employment. These ideals are an admirable foundation on which a very efficient organization has been built up, and while the managers have not consciously formulated and followed the eleven other efficiency principles, they are applying most of them.

The ideal of another company, to which they make their own profits subsidiary, is that their employees shall be able to lead wholesome New England village lives, the workers living near their homes, the fathers with leisure to retain leadership in their own families. An ideal of this kind is also an admirable foundation on which to build a highly efficient organization for, in corporations as in individuals, what is the profit of gaining the whole world if the soul is lost?

The president of an old and large plant near New York City stated with high-minded dignity the ideals under which he and his partners managed their business, not realizing how few managers had had time or opportunity to formulate such ideals, much less carry them into practice.

"We are not money-mad. We strive to be worthy sons of the worthy fathers who started this manufacturing business two generations ago. We wish to see our employees prosperous, well-paid, not overworked; we wish to surpass the world in the excellence of our product."

These are lofty, kindly, homely ideals and the efficiency engineer can frame this picture with all the other principles.

As to definite ideals, we could with profit learn from by-gone ages, although substituting other inspirations. Over one of the Greek Temples the words were carved "Know Thyself," for which we could substitute "Know the spirit rather than the externals of your business."

In the monasteries of a great religious order, every where was the inscription "Remember that death comes." For this we can substitute "Remember that we must endure." One great manager impressed on his workmen that there were just two ways of permanently raising men's wages. To obtain more from the purchaser, or to lessen unit cost of product by eliminating wastes.

The vagueness, the uncertainty, the aimlessness that characterizes employees is but an infiltration of the vagueness, uncertainty, aimlessness, that characterizes employers. There can be no legitimate conflict between rails and locomotive, between locomotive and its engineer and its fireman, no legitimate conflict between engineer and despatcher, no conflict between despatcher and time-table which defines to a second the running time of a train going at extremist speed for a thousand miles or more.

If every manager would formulate his own ideals, promulgate them throughout his plant, post them everywhere, inoculate every official and every employee with them, industrial organizations could attain the same high degree of individual and aggregate excellence as a base-ball league. These ideals ought both specifically and by implication to include much that rational labor unions strive for; they ought as definitely to exclude ideals incompatible with efficiency.

For the manager endowed with common-sense but two courses are open. To set up his own ideals and reject all efficiency principles that do not accord with them, or to accept the organization and principles of efficiency and create correspondingly high ideals.

THE ETHICS OF ALLOWANCES FOR DEPRECIATION

By L. S. Randolph.

Depreciation has been and still is a topic of bitter controversy among accountants. Many of the arguments, however, like those of the old schoolmen, are mere cavillings over words, or dry mechanical propositions that wholly miss the sense and spirit of the subject. Professor Smith's discussion brushes away these quibbles over exact percentages and level or graded deductions, and goes to the heart of the matter—the essential factors involved, their operation, and the effect (upon all the interests concerned) of each of three possible general policies.—THE EDITORS.

THAT the problem of depreciation is as yet unsettled goes without saying; that certain phases of the question need discussion, particularly the ethical aspect of the question, is the excuse for this article.

The meaning attached to the word depreciation should be thoroughly understood if we are to form a proper and accurate conception of the question at issue. Depreciation is frequently made to include that fall in value due to the physical or material decay of a structure. It is true that physical decay might be considered as one element of depreciation; but it should be under the head of repairs or renewals, as all physical decay can be renewed or repaired so as to make the structure as good as new, and hence make the depreciation from that cause zero. Accuracy cannot be obtained by grouping together widely varying elements. Let us therefore formulate the following definitions:

Depreciation is the fall in value from any cause whatever which is unpreventable, the essential element being that the machine or structure becomes obsolete.

Renewals are the expenses incurred in replacing the decayed, overstrained or broken members, the essential element being the replacing of a part or parts which are not expected to be renewed under ordinary operative conditions.

Repairs are the expenses incurred in replacing or refitting those parts which are worn out only, the essential element being that the parts were expected to wear out and be replaced under the ordinary conditions of operation.

Depreciation may be due to one or more of the following causes:

Capacity too small for economic manufacture, as in the case of railway locomotives and cars; small cars not being able to compete with canals, whereas, large cars can.

Product superseded by product of other machines, as in the case of large steam hammers which have been superseded by hydraulic forging presses.

Demand for product ceasing, on account of change of fashion, as in the case of bicycles.

Installation of more modern machinery, as in the case of the turret lathe and automatic machines superseding the ordinary lathe.

Introduction of new processes of manufacture, as in the case of steel superseding iron.

Legislation causing changes of economic condition, as in the case of the Dingley tariff closing the tin-plate mill of Wales.

Every manufacturer must meet these questions, as a new process may at any time be introduced which will produce the product at such figures as to drive him from the market.

Millions of dollars were invested in the bicycle business, magazines were filled with advertisements and hundreds of bicyclists were seen where none are seen now.

At the present time, enormous sums are being expended in the erection of plants for the manufacture of automobiles; and the only things, apparently, which will keep the business from following the course of the bicycle industry are that the motor vehicle has a wider commercial use than the bicycle and does not depend for its motive power upon the personal exertion of those who use it. It must be admitted that these are precarious arguments upon which to trust for a long productive life of any automobile plant.

A low rate of depreciation is simply an assumption that the productive life of the plant will be long.

A hydro-electric power plant is considered, generally, as typical of a long-lived plant, and yet it may at any time be met by the competition of a steam plant which can use its exhaust steam for heating in winter and refrigerating in summer, the income from the last two being more than sufficient to pay the operating expenses of the entire plant, leaving the power as a by-product to be sold for what it will bring. Under such conditions the hydroelectric plant would become obsolete, its only salvation being that heating and refrigeration may not be able to supply the demand with *by-product* power.

The history of mechanical engineering is filled with instances of the rapid changes from one process or method to another; so rapid are these at times, and so uncertain are they, that any accurate estimate, if not impossible, would, to say the least, require prophetic powers.

Assuming that no accurate estimate can be made, we are confronted with the following alternatives:

1.—To make no allowance at all for depreciation.

2.—To attempt to make an accurate allowance.

3.—To make an allowance which will be on the safe side.

It is just here that the ethical side of the problem presents itself.

The investor purchasing the bonds, preferred stock, or, in fact, any of the securities of a corporation, may justly require:

1.—That he shall obtain his dividends or interest.

2.—That the property given as security for his investment shall be well taken care of.

3.—That upon the maturity of the securities, if they have a definite period of maturity, there shall be sufficient equities to meet his claim for the return of the money he invested.

It is manifest that any conservative investor would have declined to purchase had there been the slightest idea, on his part, that these points would not be carefully looked after.

It is to the investor in securities other than capital or common stock that the last item is peculiarly important. The common-stock holder is interested in the first two of these items only. In the third item, which covers the question of depreciation, his natural interest is contrary to that of the overlying-security holders, for what they do not receive will come to him in dividends, smaller depreciation allowance meaning larger dividends.

We are considering, therefore the relative rights of the common-stock holder and the overlying-security holders and must in fact sit in judgment on the claims of these two.

We can at once put aside any contention that no allowance at all shall be made for depreciation. The past history of commercial organizations is filled with the wrecks caused by failure to make an allowance for depreciation. The president of one of our large trunk lines remarked upon one occasion that "the principal cause of disastrous failures, from the corner grocery up, was that they carried goods on their inventory at cost price long after they had become useless."

There is a record of one railroad which carried a large surplus besides paying heavy dividends. When the end came it was found that money had been borrowed from the surplus fund to replace obsolete and worn-out equipment (depreciation and renewals). Imagine what the conditions of affairs would have been, had the dividends been increased instead of passing the money to the surplus fund. Investors were buying this stock at a price based on the dividends *plus* the amount passed to the surplus fund, equivalent to some 15 per cent to 16 per cent on the stock, whereas the actual earnings, if a proper depreciation allowance had been made, would not have justified a dividend rate of 4 per cent.

If an attempt is made to predict accurately the productive life of a proposition we are apt to have results such as are described above; and while the results will not be so disastrous, nor be obtained every time, (as in the case where there is no allowance for depreciation) yet there will be very many similar cases—too many, in fact, for the best interests of good business. Wherever the productive life is over-estimated there will not be sufficient equities to satisfy the just and proper claims of security holders, and with the natural and altogether human tendency of the common-stock holder to err on the side of his own interests, this over-estimation will occur more frequently than not.

The third method—viz, that such a rate or allowance for depreciation should be used as will always give results which will be on the safe side—may be criticised as impracticable. The law of the special machine ("that no special machine can be economically installed unless the saving, on the work in sight, will pay for the machine installed, less its scrap value") may be said to be a special case where depreciation is, without any question, on the safe side.

When we apply this law to the question of depreciation, we observe at once that the phrase "work in sight" contains the gist of the matter. When we use as similes for this phrase "work of which we are absolutely sure," "work under contract," we understand the meaning of the phrase.

It may be argued that where the absence of an allowance for depreciation works an injury to the holders of overlying securities, an allowance which will always be on the safe side works an equal injury to the common-stock holder. This can readily be shown to be untrue. In the first case, what should have been set aside for depreciation goes to the stock holder and cannot be recovered either in whole or in part. In the second case all that is set aside for depreciation goes first to satisfy the claims of the overlying-security holders, the remainder going to the common-stock holders who receive, in the end, all that should come to them; the only hardship being that they do not receive it as early as they should; they receive, however, interest on those amounts which would have come to them earlier had an accurate allowance for depreciation been made. Can we not therefore sum up these arguments as follows:

No depreciation allowance, or an assumption of infinite productive life, will ultimately deprive the overlying-security holders of the capital invested.

An attempt to determine the exact depreciation allowance will have the same effect in a large proportion of cases as no depreciation allowance at all, so far as the overlying-security holders are concerned.

With a depreciation allowance which is on the safe side, the overlying-security holders are fully protected and no hardship can be complained of by the common-stock holders.

Can it not then be safely stated that anything other than a safe allowance for depreciation or productive life is constructive fraud?

THE HEATING, VENTILATING AND AIR-CONDITIONING OF FACTORIES.

By Percival Robert Moses.

1. ITS ECONOMIC IMPORTANCE—SYSTEMS FOR TEMPERATURE CONTROL.

In two articles, of which this is the first, Mr. Moses reviews broadly the whole practice of air-conditioning, as to temperature, humidity, and purity. He outlines methods and the apparatus by which they are carried out, and presents foundational data on which good practice should be based. THE EDITORS.

UNTIL recent years, attention to the ventilation and heating of factories was confined to the delivery of fresh air and the withdrawal of vitiated air, but the scope of this subject has been greatly enlarged and the modern ventilating plant takes care not only of the supply and withdrawal of air but the regulation of the quality of the air. The regulation of the quality includes the temperature control, the control of the humidity (i. e., per centage of moisture) and even the control of the chemical constitution. It involves the cleaning of the air, and frequently its sterilization. Ventilating apparatus is also used for the removal of dangerous dust or gases, and without this apparatus many manufacturing processes would be impossible or extremely dangerous.

The supply of fresh, clean, tempered air has been recognized for many years as a necessity, and its effect upon the character and quantity of the work turned out is beginning to be fully understood. The expense of providing pure, fresh air is not excessive if the system is competently designed, as will be explained later.

The necessity for ventilation arises from the fact that the average person breathing in air containing nearly 21 per cent of oxygen breathes out this air with only 16 per cent of oxygen. It becomes necessary, therefore, to introduce fresh oxygen, and the easiest way of introducing this fresh oxygen is to bring in extra supplies of air containing the oxygen. In order to allow this air to be brought in, it is necessary to provide means for withdrawing the vitiated air.

The oxygen breathed in by the person combines with the carbon in the blood and forms carbonic acid, and this carbonic acid in the form of gas mixes with the air in the room. On this account, the percentage of carbonic-acid gas found in a room is usually taken as the measure of the purity of the air. A word of caution is neces-

INSTALLATION OF 104 24-INCH "GLOBE" VENTILATORS, FACTORY OF THE LIBRARY BUREAU.

sary here, as in many cases the percentage of carbonic-acid gas will not be a measure of the purity of the air and of its fitness for breathing. Carbonic-acid gas itself is not dangerous in the quantities in which it is found; it might be present to ten times the amount usually allowed in good practice before it would become actually dangerous. But before this condition could be reached in ordinary workshops or factories the air would be unbreathable.

The usually accepted requirements for good ventilation are as follows:

Two thousand cubic feet of air per hour should be supplied for each operative; this air to be free from dust or other impurities and to be delivered at such a temperature as will maintain the temperature of the room between 60 and 70 degrees F., the humidity being maintained at 68 to 70 per cent relative humidity. The air should be delivered in such a manner as will not create an appreciable draft.

The result of such a supply will be indicated, in general, by a percentage of carbonic-acid gas of less than 9 parts in 10,000.

The necessity of providing ventilation in workshops and factories was strikingly shown by an investigation carried on by the Commissioner of Labor of New York State of the conditions existing in cigar and clothing factories, dye works, and other establishments. Instead of an allowable percentage of from 9 to 12 parts of carbonic-acid gas in 10,000, the Commissioner found from 30 to 60 parts of carbonic-acid gas in this quantity of air, indicating an extreme condition of pollution. If it is remembered that all the clothing we wear, and the cigars we smoke, are manufactured in conditions of this kind, the importance of ventilation to the general public will be appreciated, and its importance to the workmen is far greater.

Besides the requirement of ventilation from the sanitary point of view, there are many special cases of ventilation:

In wood-working plants some means of withdrawing dust and sawdust is a necessity, because of danger from fire.

In newspaper establishments, where auto-plate machines are operated, the fumes must be withdrawn in a positive manner. These fumes arise from the melting of lead, the fire required for the melting, volatile acids used in the etching room, etc. The operating of modern crowded newspaper plants would be impossible without the removal of these gases.

In foundries, when the furnace is tapped and the moulds filled with molten metal, the whole place is filled with a heavy acrid smoke for which vent must be provided.

In salt mills, or blocks, as they are called, long vats sometimes hundreds of feet in length, containing steam coils and salt brine, fill the space above with moist vapor, and the steady removal of this vapor is not only essential from the point of view of the workmen, but from the point of view of the salt manufacturer, as unless it is removed the vapor will condense in the room and fall back into the salt vats, causing discoloration and a marked deterioration of the product.

In storage-battery manufacturing plants, or in buildings containing storage batteries, some provision for drawing off the sulphuric-acid fumes is a necessity, as otherwise the fumes would cut everything they come in contact with. I have seen all the copper on a panel board eaten away by the storage-battery fumes, and I have also seen places where the curtains and upholstery of an apartment were destroyed by the sulphuric-acid fumes creeping along the pipe openings provided for steam risers. The manufacture of storage batteries is very dangerous, as fumes are produced which cause decay of the gums, falling out of the teeth and, in time, death. The workmen have to wear masks to protect themselves, and the withdrawal of fumes is of utmost importance, as life depends upon it.

In potteries, it is absolutely essential for health that the dust be removed as made.

Further on in this article mention is made of textile and silk mills, where the percentage of moisture is of importance, and in printing establishments this is also true, as it has been found that where the air is too dry the paper sticks together and feeding becomes difficult.

In sugar mills very much the same conditions are met with in some parts of the process as in salt mills, but the amount of vapor is very much less, and on account of the method of evaporation employed, which is the multiple-effect method (enclosed vessels) the larger part of the evaporating process is carried on without open vapor.

In flour mills and starch mills very finely divided dust must be removed, as it is formed, if an explosion is to be averted. All apparatus, such as a direct-current electric motor, where contact may produce a spark, must be eliminated. One of my clients recently had his whole mill destroyed by the explosion of starch dust. So far as they knew, no sparks or open flames were permitted on the premises.

In the coal breakers, where the coal coming from the mines is graded and sorted, it is really heart-breaking to see small boys hardly out of their teens picking out the larger lumps, their faces begrimed with black coal soot, their nostrils and lungs full of the same stuff. Conditions such as these are absolutely unnecessary and if continued are a crime against society. I was informed by a doctor of the district that a large percentage of the boys and men employed around the coal breakers die of consumption and pneumonia, due mainly to the condition of their lungs from the coal dust.

In metal-working establishments, where buffing and polishing machines are used, there is a very fine emery dust which must be drawn away from the machinery as it is made, otherwise it will get into the lungs, causing irritation and a diseased condition.

In such factories as woodworking factories, where lacquering rooms are frequently found, the withdrawal of the lacquer vapor is essential for safety against fire.

These may be called the special requirements of ventilating plants, and there is hardly a business of manufacturing in which one or two special ventilating conditions are not present.

The main divisions of the ventilating problem are:

1.—Supply of fresh aid and withdrawal of vitiated air.

2.—Heating of this air and the heating of the building.

3.—Regulation of the quantity of the moisture in the air supplied and in the building.

4.—Cleansing of the air supplied.

5.—Cooling of the air supplied and of the building.

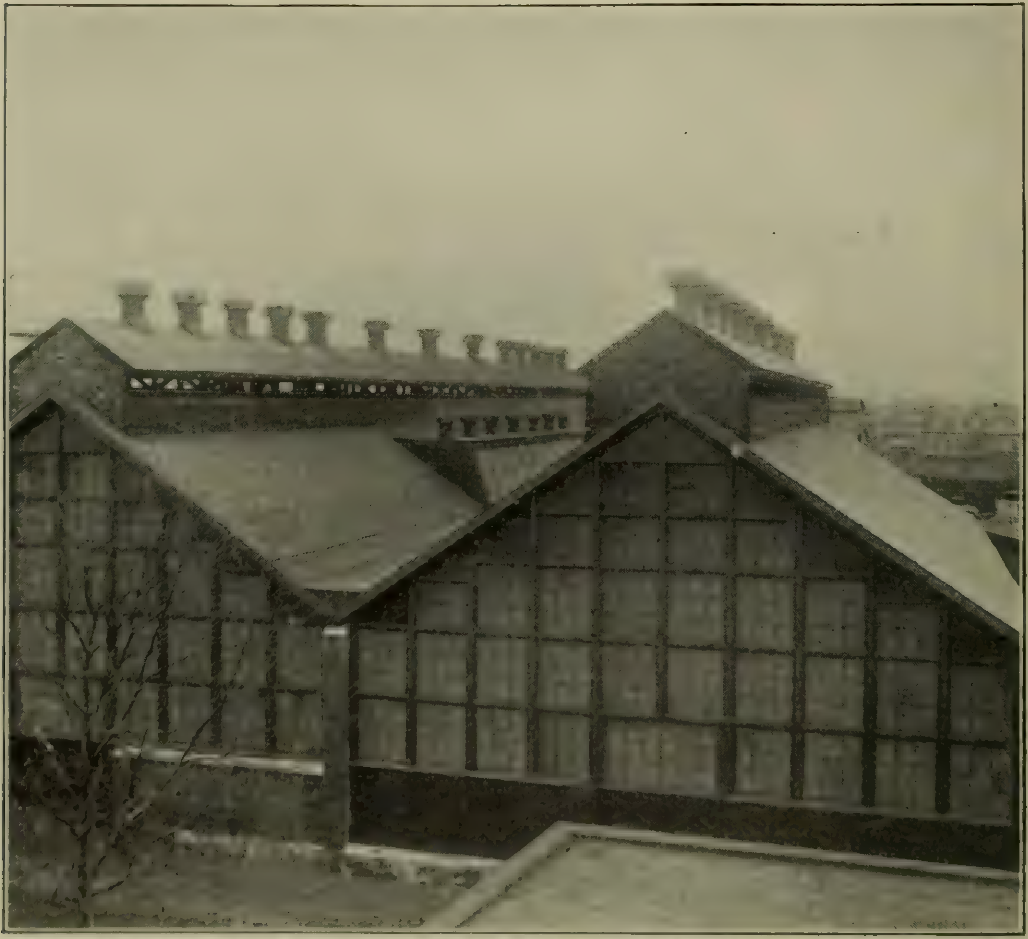
All these divisions are intimately inter-connected. It is not possible to regulate the humidity of the air without regulating its temperature, and it is not possible or economical to consider the ventilation of the building without taking into account the question of heating or cooling, as the case may be.

It will be well to consider first, briefly, the methods employed for supplying and withdrawing air and for tempering the supply. The most important method of ventilation is the natural method, because it is the one most frequently used for ordinary workshops and factories where regulation of the quality of the air is not so essential as the quantity. There are many months in the year when natural ventilation can be resorted to, and it is only when the question of heating, cooling, or humidity regulation come in that natural regulation fails fully to meet the conditions. Natural ventilating methods include the use of movable skylights, window ventilators, or roof ventilators of the Star, Pancoast or Pullman type. Air is allowed to come in through windows with special ventilators, and the usual method is to provide for heating it by radiators or coils around the walls under the window. For ordinary factories, where the number

SCHOOL-HOUSE VENTILATED BY 48-INCH "ROYAL" VENTILATORS.

of employees is not excessive, these systems give satisfactory results, except in very cold weather when all the windows are likely to be kept closed.

Where natural ventilation is contemplated, it is a good plan to provide some means for the admission of the air without causing direct draft upon the people working in front of the windows. There are many devices for this purpose on the market, and all contemplate allowing the air to enter and be deflected in a vertical plane. The objection to natural ventilation is that the quality and quantity of the air cannot be regulated. Differences in the direction and pressure of the wind will vary the quantity of air delivered through a given opening, and in some cases will even cause an outflow of air.



NATURAL VENTILATION OF MONITORS, EDGE-TOOL FACTORY OF THE FAYETTE R. PLUMB CO.

Thirty-five 20- and 30-in. "Royal" ventilators.

With mechanical ventilation, the quality and quantity of the air may be regulated with a great degree of precision and the conditions in the workshop maintained fairly uniform. Every mechanical system must provide not only for the supply but for the withdrawal of

TWENTY-FOUR 48-INCH "GLOBE" VENTILATORS, POWER-HOUSE OF THE BOSTON ELEVATED RAILWAY.

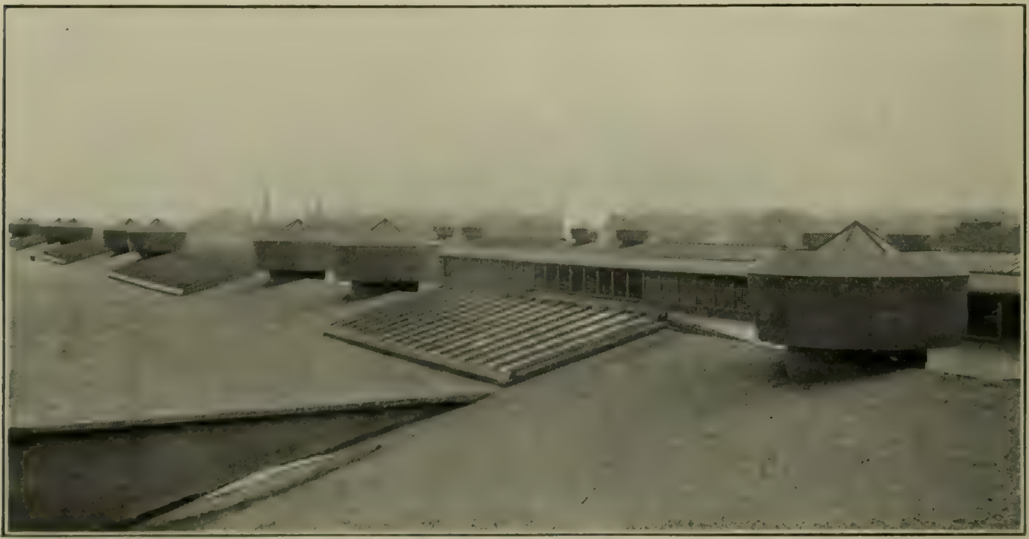
the air; one is useless without the other. A rather striking example of this was seen in a well-known newspaper building in New York City, where an elaborate ventilating system had been installed for the composing room. The original system provided merely for a supply system, delivering approximately 35,000 cubic feet per minute, and this quantity of air was sufficient to change the air in the composing room every 4 minutes, provided some means of withdrawing the foul air had been installed.

The conditions when examined were found to be quite bad, about 30 parts CO_2 in 10,000, notwithstanding this ventilating system. An exhaust system capable of withdrawing 41,000 cubic feet per minute was installed, with a special exhauster for the linotype machines which give off a quantity of fumes and heat. Since the installation of the exhaust system the carbonic-acid gas has been

NATURAL VENTILATION, RICHARDSON PAPER CO., LOCKLAND, OHIO.
Sixty-six Swartwout gravity-closing ventilators. Ohio Blower Co.

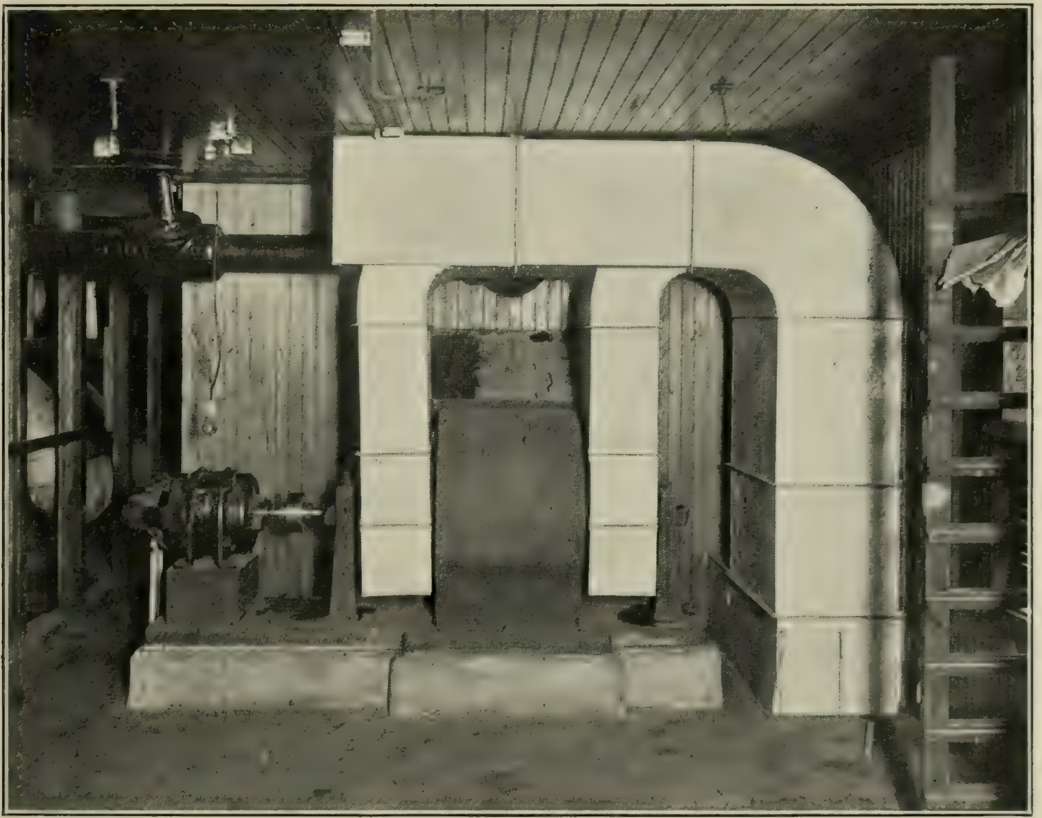
reduced to between 5 and 6 parts in 10,000, the outside being 4 parts in 10,000.

The folly of attempting to do things by halves was also shown in a lecture room. The plan had been prepared providing for an inlet, or, rather, an intake, of fresh air over coils, the air being distributed through the room by a number of openings underneath the seats. The air was to be withdrawn from the room by a large exhaust fan placed in one corner. The authorities decided to go ahead with the scheme, but only put in one-half; that is, they decided to put in the exhaust fan. This room was an entirely enclosed room, and during a lecture the only way air could be admitted to the room was through the windows, and as these windows were right alongside the students, any attempt to open the windows sufficiently to provide the necessary air caused dangerous draft, and naturally the apparatus could not work. One of my assistants went down with an anemometer and measured the velocity of the air going out from the fan with the door of the lecture room open, and with the door of the lecture room closed. The reason for the non-performance was clearly shown, as when the door was open and free admission of air allowed to the lecture room, the fan delivered a certain quantity of air. As soon as the door was closed, however, there was found to be a circulation of air right around the fan; that is, the air came in through the fan at the center and went out at the edges, so that insofar as the ventilation of the room was concerned it was doing no work.



NATURAL VENTILATION, TRAIN SHED OF TOLEDO RAILWAY AND TERMINAL CO.
Seventeen 48-inch "Royal" ventilators.

The usual method of supplying air is to allow the air to be drawn over coils of pipe or cast iron sections containing steam or other heating medium. These sections are known as tempering coils and their object is to prevent the delivery of air below a stated temperature. This air, after preliminary heating, is then passed through a cleaning apparatus, and afterwards through a heating coil or stack where it is heated to the desired final temperature. The force causing the air to flow is produced by a rapidly revolving fan or blower. This blower is placed either between the air cleaner and the second heater or after leaving the last heater. Almost all blowers used for this purpose rely upon centrifugal force for the production of movement in the air; that is, the air is drawn in around the center of a rapidly recolving series of blades, which cause the air to revolve at a rapidity approximating that of the fan. The rapid revolution of the air produces centrifugal pressure and as soon as an opening is presented the air is discharged through the opening with a pressure depending upon the speed of revolution.



SQUIRREL-CAGE MULTIVANE VENTILATING FAN, RECENTLY INSTALLED IN THE PLANT OF THE WALTER BAKER CO.

Operated by 5-h. p. motor; double inlet. Draws in air, passes it over cooling coils to remove moisture, and delivers it into one of the cooling rooms. Massachusetts Fan Co.

There are different types of centrifugal fans, varying from the type known as the "cone" fan to the Sirocco or "multivane" type. The latter types are of recent development and rely not only upon centrifugal force but upon the actual peripheral velocity of the fan blades to impart motion to the air. The blades of the Sirocco or "multivane" type of fan resemble the blades of a turbine, while the blades of the older type centrifugal fan are similar to the paddles of the paddle wheel of the old-type steamboat.

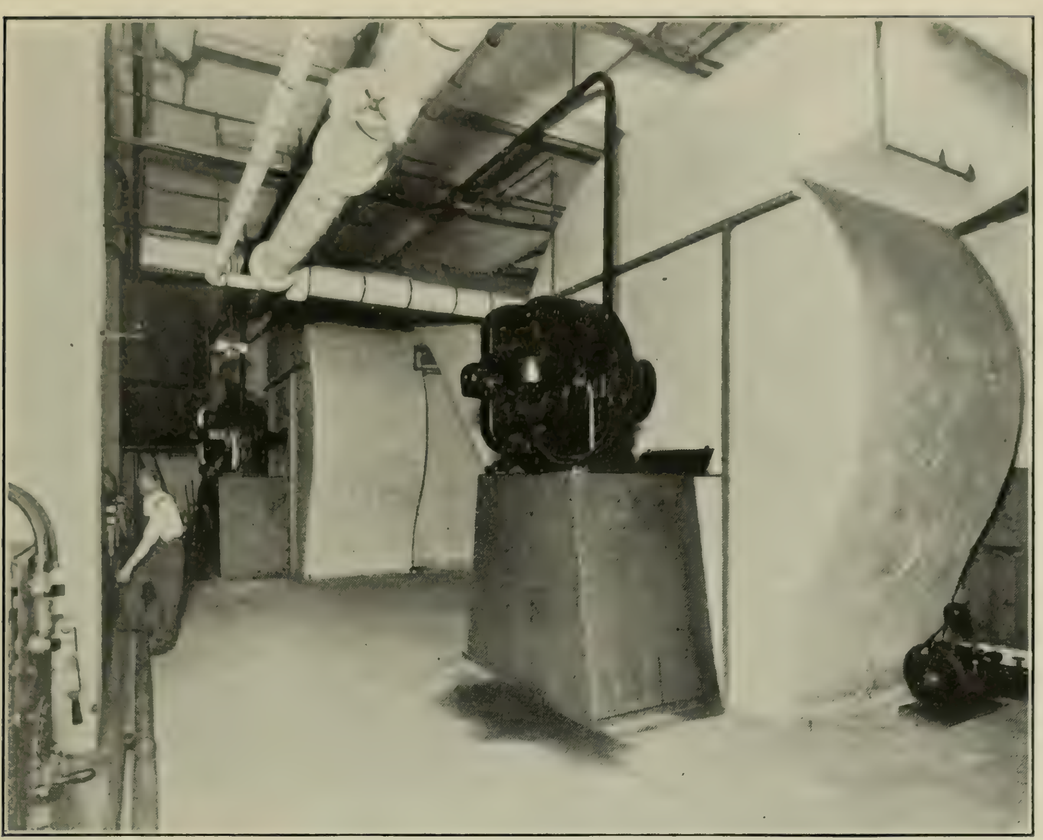
There is another type of fan used in which the discharge is into an open space. This is the "disc" type, which operates on the same principle as the propeller of a steamship.

Where any great frictional resistance is to be encountered, as in the discharge through long ducts, the "disc" or propeller type is not suitable, as its efficiency is very low and if any resistance is encountered the blades simply cut through the air without producing appreciable motion. The "disc" or propeller type fan finds its main us as an exhaust fan, drawing the air from rooms and discharging through protecting hoods to the outside air. For this purpose, they are preferable to the centrifugal type of fan, as they have a greater capacity per dollar of cost.

Where it is desired to regulate the humidity of the air, as in textile and similar mills, the regulation is effected by causing the air on its way to the fan to pass through a mist of water, completely saturating the air; or, the air is allowed to pass over a flat pan of water: In this water is a steam coil, to which steam is admitted or from which it is cut off as the amount of humidity in the air supplied varies. The admission of steam into the coil produces evaporation in the pan and causes more or less vapor to mix with the supply of air. The advantage of the first system is, that passing the air through a mist of water not only supplies humidity but also washes the air clean of dust and other impurities. Heretofore, dust has been removed from the air by a series of cheesecloth screens. These became foul in a very short while, and even in their prime condition were never able to clean air as efficiently as the water spray or shower.

The usual method of driving fans is either by electric motors, by steam engines, or directly from a countershaft used for some other purpose.

Where fans are used for ventilation only and not for ventilation combined with heating, the electrically driven fan is preferable on account of its simplicity and the ease with which it can be located wherever it is desired. It should be observed that where electricity is purchased from outside a different state of affairs exists than when the current is generated on the premises. If high-pressure steam is available for other purposes, it is usually found to be more economical to operate a steam-driven fan, using the exhaust steam



TWO OF THE VENTILATING FANS IN THE ALTMAN BUILDING.

from the fan engine to help heat the building or the feed water of the boilers. A striking example of failure to realize this fact came to my notice a few months ago in a model newspaper building, recently completed, which contained apparatus all of the highest efficiency individually; but failure to recognize interdependence of the parts caused the plant, as a whole, to be extremely inefficient. The ventilating fans in this building are electrically driven; high-pressure steam is manufactured for the purpose of operating elevator pumps and other pumps, and additional steam is taken from the boilers to heat the building. The ventilating fans are operating all day long and the air they receive is heated by steam coils. A knowledge of the steam requirements would have led to the choice of steam-driven fans, the exhaust from these steam engines being used to heat the building; thus, obtaining a double use of the steam and also of the labor. In fact, it may be safely stated that in this building no more fuel would be used in the winter if the fans were steam-driven, and a saving of at least $6 a day would be made in the electric bill. Where electric current is generated by a private plant on the premises, there is no economic objection to the electric-driven fan because the exhaust steam from the electric-generating plant can be used in the building, and the combined efficiency of the engine, dynamo and motor is better than the efficiency of the ordinary steam engine used to drive fan blowers.

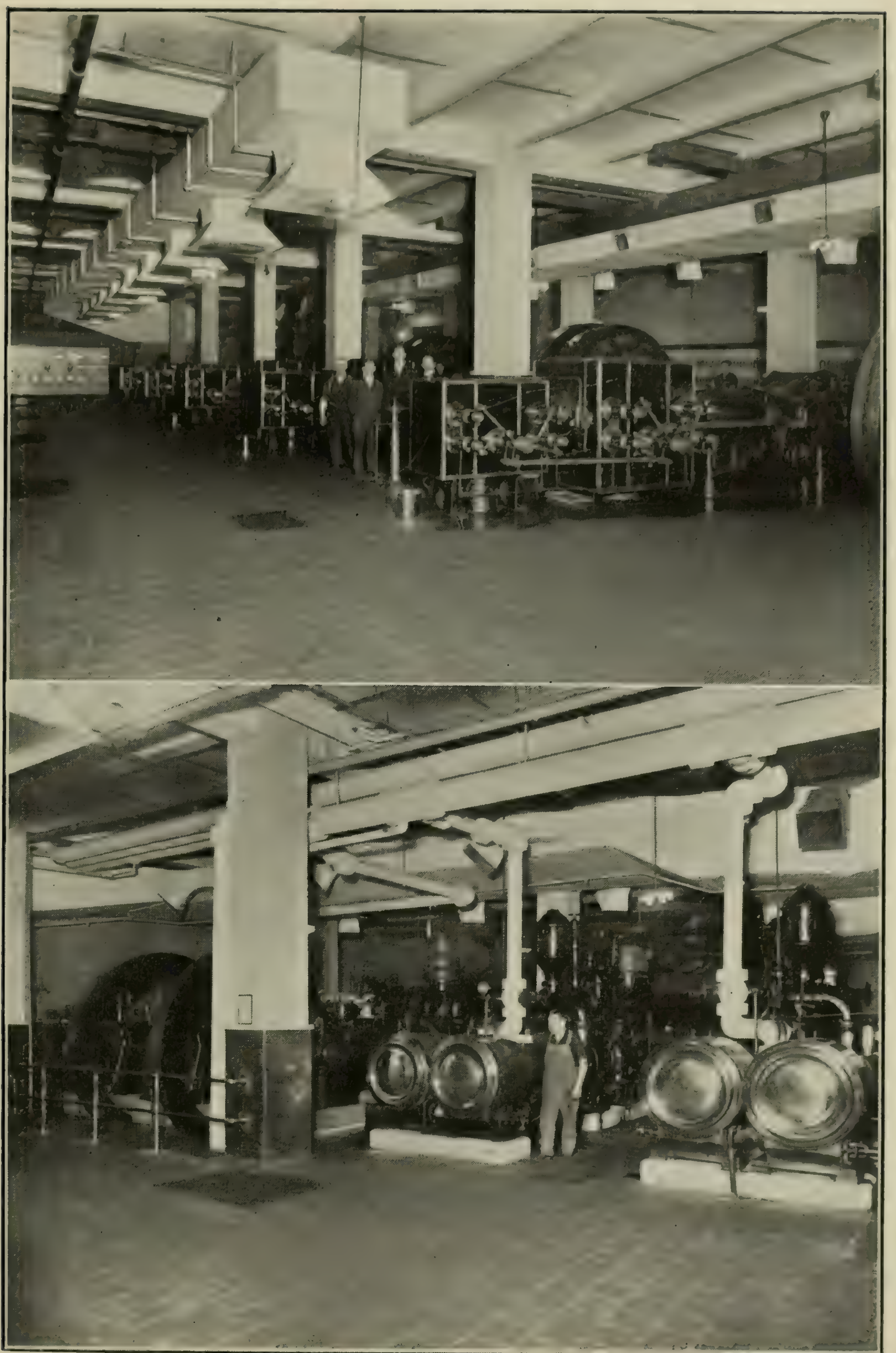
As between direct-connected, belted, and chain drive, the direct-connected motor is the most convenient and efficient, but the cost is greater because of the necessity of slow-speed motors. Belt or chain drive has the advantage of making any repairs to the motor easier, and with the belt drive speed adjustment is comparatively simple. By this I mean, that if it is found that the speed contemplated in the first place is too high, it can be readily reduced with belt-drive by changing the size of the pulley. Speed regulation with electric drive is more difficult than with steam drive, on account of the fact that the power required by a fan blower varies with the cube of the speed. For example, a so-called 100-inch centrifugal type fan—i. e., housing 100-inch with a wheel 5 feet in diameter, operating at 190 revolutions per minute will give 9,540 cubic feet of air and requires 2¾ horse power. When operating at 380 revolutions per minute it will give 19,050 cubic feet of air and will require 13 1-3 horse power. At 537 revolutions per minute it will give 27,000 cubic feet of air and will require 36 horse power. Hence, if it is desired to provide for the reduction in the quantity of air delivered by a fan to 50 per cent of the rated quantity, it becomes necessary to provide for absorbing five-sixths of the power delivered by the motor and this involves great waste, while with a steam-driven fan the speed can be regulated readily by adjusting the opening of the throttle valve.

In most ventilating work, however, it is not usual to vary the speed of the fan by any great quantity, the amount of air supplied being adjusted by opening and closing of the dampers, the fan being arranged to operate at its maximum speed regularly.

Where it is necessary to exhaust gases, or hot air, or air carrying quantities of dust, the motor must be protected from contact with the air or gas taken out. If the fan be of the disc or cone type it becames necessary to detach the motor from the fan, while if the fan is of the centrifugal type the connection between motor and the fan must be made dust and gas proof.

Medium for the Transfer of Heat from the Coal to the Air.

The medium most generally employed for the transfer of heat from the coal to the air is steam. The reason for this is that in this the way the by products of power manufacture—i. e., the exhaust from the steam engines—may be used; the automatic regulation of temperature is comparatively easy, and there is but little wear and tear to the apparatus. Hot water is also used for this purpose and



PARTS OF THE MECHANICAL INSTALLATION IN THE DEPARTMENT STORE OF B. ALTMAN & CO., N. Y., SHOWING THE VENTILATING PLANT.
Above is a general view of the engine room. Below, the elevator pumps.

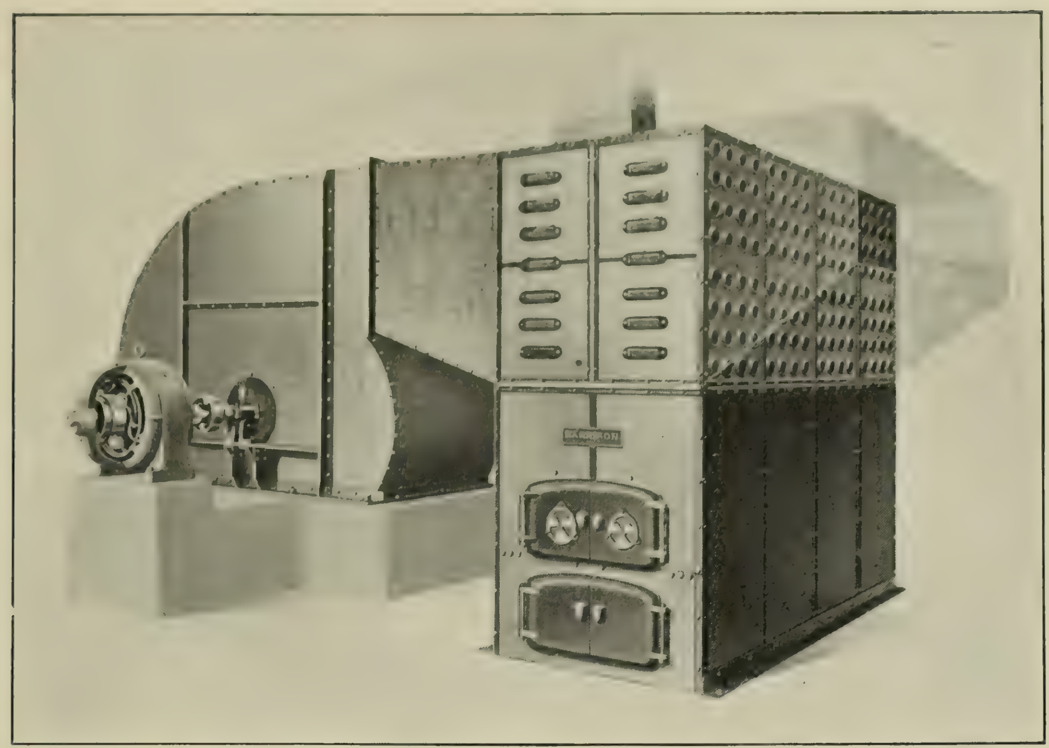
the advantage claimed is that the temperature of the water can be varied to meet the weather conditions. This is true, but substantially the same results can be obtained from steam coils by subdividing the heating surface so that the small portion may be used in mild weather and additional surface added in cold weather. The hot-water system has the disadvantage of large residual heating capacity, making quick regulation more difficult. There is also a greater tendency to wear and corrosion.

In one hot-water forced-circulation system the exhaust steam from the steam plant is used to heat the water required for the heating coils, and as the temperature of the water varies the degree of vacuum maintained on the engine varies. Equal results could be obtained with a steam plant by sub-dividing the steam plant into several units, one or more of the units being operated non-condensing during the winter's season when steam is required for heating; the load being divided up in such a manner that only sufficient load would be thrown on the non-condensing engine to provide for the necessary exhaust heating. Or, as is being done in several cases now, the plant may be divided into gas engines and steam engines, sufficient steam-engine power being installed to take care of the steam heating when operating non-condensing, while during the non-heating season and for all parts of the load not required for heating purposes, high-efficiency gas engines are used.

The use of direct furnaces for heating the air has also been advocated but, particularly in workshops and factories, the field for this type of apparatus is limited, partly because of the requirements for steam for power. I am inclined to think also that the wear and tear on this apparatus would be much greater than on steam apparatus, and there would be more difficulty in maintaining the equipment in prime condition.

The use of exhaust gases from gas engines is rapidly finding favor. In this system the exhaust gases from the engine pass through cast-iron heaters containing water. As these exhaust gases from the engine come out at about 1,000 degrees F., there is a considerable opportunity for saving by their utilization. It has been found in practice that about 2½ pounds of steam per hour can be obtained from a horse-power of gas engine by utilizing the waste gases and such part of the jacket water or water used for cooling the piston and piston rods as may be needed to supply the vaporizer.

The objection to using exhaust gases is that they contain a quantity of hydrogen and usually some sulphur, and if water is present there is a tendency to corrode. Hence, the use of cast iron.



HARRISON AERTUBE HEATER, FOR UTILIZING DIRECT OR WASTE HEAT BY TRANSMISSION THROUGH TUBES.
The air is propelled through the tubes by the fan, the hot gases passing around the tubes. Harrison Engineering Co.

If the Tait process is used for operating gas engines, the hydrogen practically disappears, as the producer gas used in the engine is practically carbonic monoxide and nitrogen. In this system, the exhaust gases from the gas engine are used in the producer instead of a steam blast, and as there is no danger of corrosion, any type of heater may be used; in fact, Mr. Tait recommends the use of an ordinary vertical tubular boiler, but my experience with such boilers would lead me to advise that if such a boiler is used it should be equipped with charcoal iron, copper, or brass tubes, not because of any corrosive action of the gases but because of the tendency to pitting and corrosion from the water inside of the boiler.

The use of a spray system of hot water for the preliminary heating of incoming air is rapidly finding favor as it not only heats the air but cleans it. The hot water should be used for tempering only, as if an attempt were made to do all the heating by a spray system and air anywhere near the saturation point of 150 degrees F. were delivered into a room and allowed to cool to 70 degrees, a great quantity of moisture would be precipitated.

Location of Heating Surface.

From the point of view of fan operation, the location of the heating surface on the discharge of the fan is the best, because with this arrangement a fan of a stated size will discharge the greatest quantity of air, as it receives the air at the greatest density. The difference in volume of air at 32 degrees and 140 degrees is practically 25 per cent; hence, if the heater is placed on the inlet of the fan, the capacity of the fan is reduced very nearly 25 per cent. On the other hand, there are many conditions where the location of the heating surface on the discharge is not practicable. In placing the heating surface on the inlet, the air can be allowed to find its way through the coils into a chamber from which the fan draws. If the heating surface is placed on the outlet, the discharge from the fan has to be gradually enlarged until it is big enough to take in the whole heating surface and then has to be gradually reduced. This involves a great deal of space, and where this is of importance it becomes necessary to place the heating coils on the inlet. Where a building is divided up and different quantities of air and heat are to be supplied to different divisions, it becomes necessary to resort to re-heaters placed on the flues leading to the individual rooms, or to direct radiating surfaces placed in the rooms.

The coil placed on the inlet is usually termed the tempering coil, and it is important that this coil be diveded so that more or less may be used as the air outside decreases or increases in temperature. A division into three or four sections is usually sufficient. These sections should be hand-controlled and should be regulated in accordance with the weather condition outside. In addition to this hand-control, there should be automatic control. Automatic control on the tempering coil includes two functions. First, there is usually an automatic thermostat placed outdoors so that when the temperature falls below 32 degrees one of the coils is automatically thrown into the circuit to prevent freezing up. A second thermostat is placed in the discharge duct. This thermostat operates, whenever the temperature in the discharge duct falls below the desired quantity, to open up the steam supply and to close the by-pass damper, and when the temperature rises above that desired, it cuts off the steam supply and opens the by-pass damper. This insures a steady air temperature in the supply duct. If reheaters are required, these may be either hand-controlled or controlled by thermostats located in the rooms heated.

THE REVIVAL OF THE RECIPROCATING STEAM ENGINE.

By R. J. S. Pigott.

Mr. Pigott's theme is the very high economy in the production of power secured by the large piston engine combined with the low-pressure turbine. A preceding article, published in our July issue, dealt with thermal considerations and problems of design in getting up a good combination unit. This concluding paper discusses practical applications, either to new installations or revision of old reciprocating-engine plants by the addition of low-pressure turbines.—THE EDITORS.

THREE phases of low-pressure-turbine application are interesting as showing the various fields in which the steam engine is again pushed to the fore. Of course, since the engine-turbine combination is more efficient than either engine or turbine alone, no matter what the general conditions are, the thermal efficiency of any engine plant can be improved by the addition of low-pressure turbines. But the chief field is in adding to plants already installed, since the high first cost and consequently the high fixed charges against the combination unit militate against it as an initial installation for plants where the load factor is low. The three phases are:—large and economical engines, operating in a power house; medium size and less economical engines, in a manufacturing plant or small power plant; and engines to be designed and put on the market expressly for such low-pressure-turbine combination service.

In the case at 59th Street power station, which is such a notable example, the calculation of the situation was comparatively simple, and accurate to a more refined degree than would generally be the case, since a set of careful tests were available to show the relation between indicated water rate, actual water rate, and ratio of expansion, or, as Perry calls it, ratio of cut-off. The following discussion is intended to apply only to large-size compound condensing engines.

The first thing to do in computing the conditions resulting from a low-pressure-turbine installation is to establish a formula for variation of y, the missing water, with r, ratio of cut-off under the existing operating condition. This is done by plotting actual water rate per indicated horse power, indicated water rate, and ratio of cut-off,

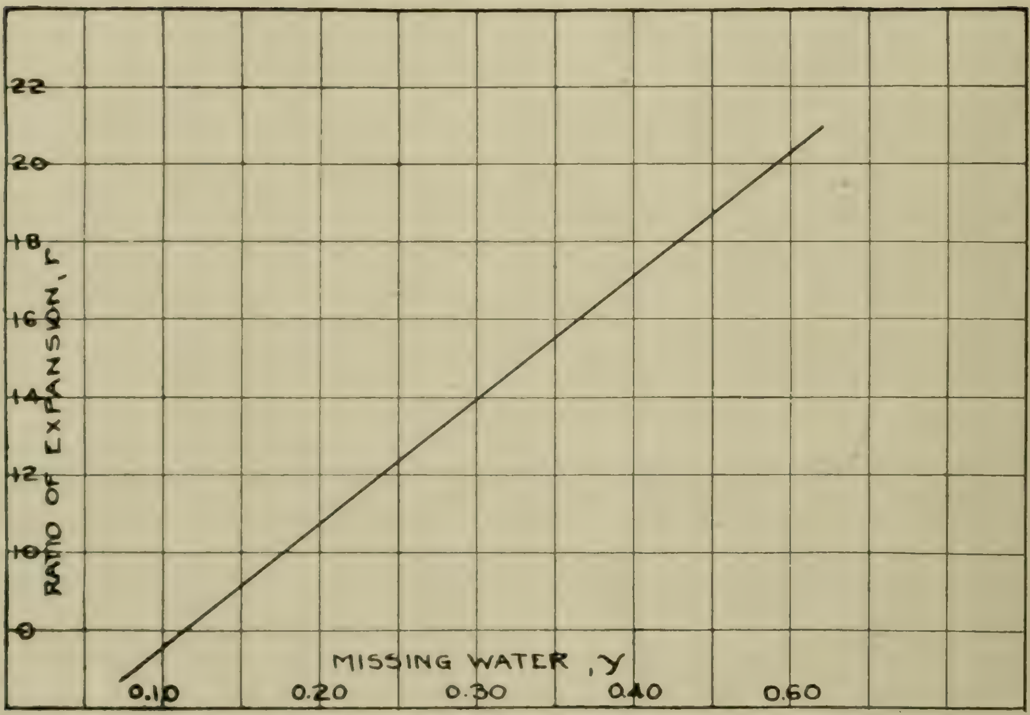


FIG. I. EVOLUTION OF FORMULA FOR MISSING WATER.

From test data:

$$y = \frac{(\text{Actual water per I. H. P. per hr.}) - (\text{Indicated water per I. H. P. per hr.})}{\text{Indicated water per I. H. P. per hr.}}$$

$$r = \frac{\text{Total L. P. cylinder volume.}}{\text{H. P. cut-off volume.}}$$

Plotting the curve from the above, the equation of the line is $y = \beta r + a = .0317\, r - .137$.

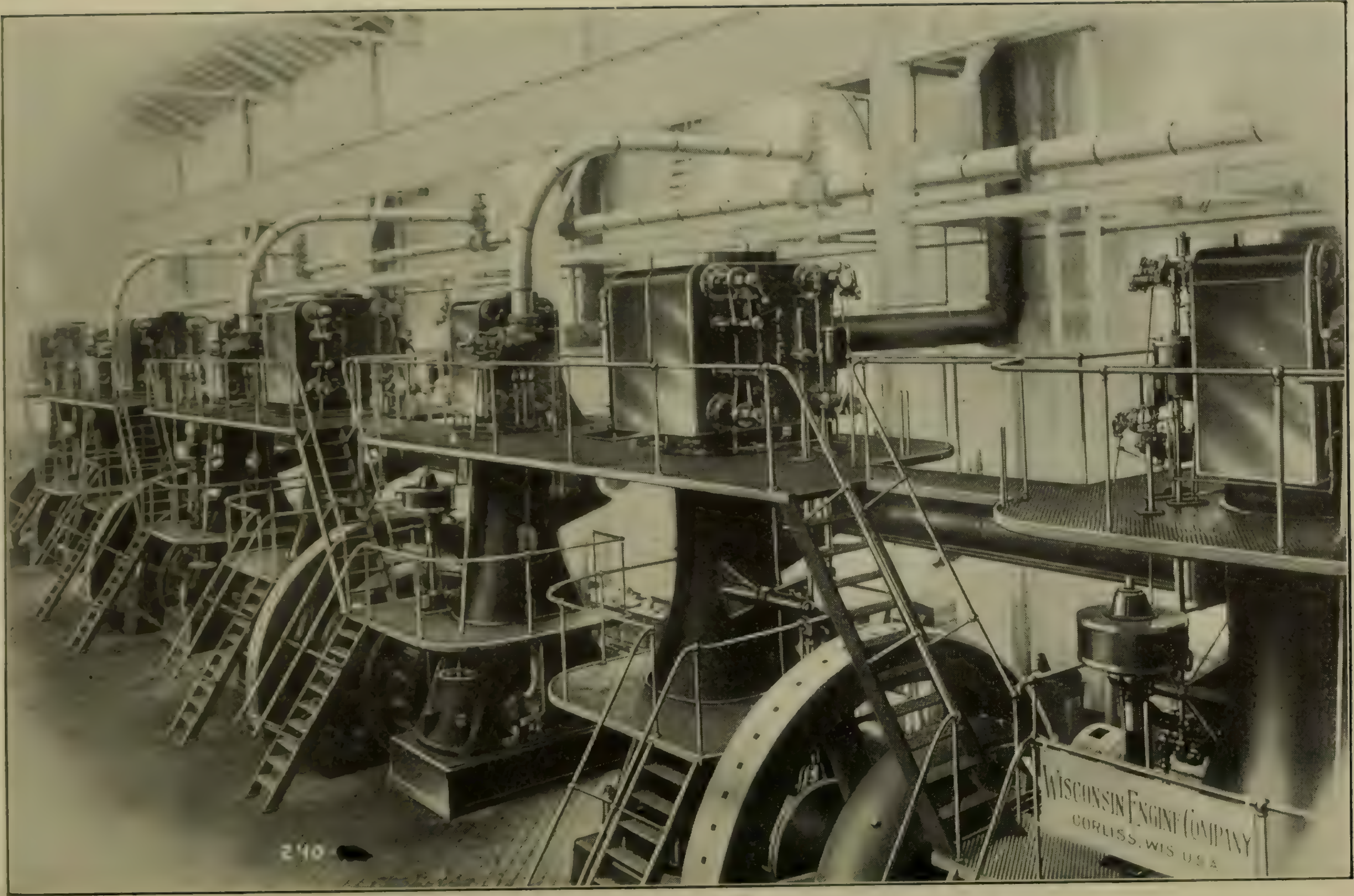
against total indicated horse power, as shown in Figure 1, and substituting values in an equation of the form $y = a + \beta r$. This is for the engines at 59th Street plant, operating on 190 pounds steam at the throttle, about 5 degrees superheat, 28 inches vacuum, no reheaters or jackets, size 42 and 86 inches by 60 inches, double compound, speed 75 revolutions per minute, maximum rating 7,500 kilowatts. The formula only accounts for y at high-pressure cut-off. Now this missing water will only be affected at any given r by the pressure range in the high-pressure cylinder, for the same engine, other conditions of steam and speed, etc., being constant. Consequently, y will not be much altered by changing from condensing to non-condensing conditions, since the receiver pressure will be increased only by a few pounds. So that y as obtained above will be practically correct for the engine in both cases.

The next step is to assume indicator cards for the new conditions. There are two possible conditions under which the engine may be required to operate; with fixed back-pressure at all loads, corresponding to variable nozzle-area admission to the low-pressure turbine; and with back-pressure varying with the load, corresponding to fixed nozzle-area admission to the turbine. In general, varying back-pressure operation has the advantage; no regulating device of any kind is necessary on the turbine inlet nozzles, nor any attention on the part of the engineer to this pressure; it is likely to be more economical than the fixed nozzle pressure (this point will be brought out more fully later); it gives better operating conditions on the engine, especially at light loads. On the other hand, with fixed nozzle pressure, the piping from engine to turbine is never under vacuum, thus lessening the risk of air leakage to spoil the turbine vacuum; but this point becomes unimportant if the piping is properly designed and erected. For the case of constant back-pressure, it may be possible to run the engines non-condensing at this pressure (about 16 to 20 pounds absolute) and get test data of water rates and cards. This is, of course, very desirable. But in case it cannot be done, the cards must be assumed for both cases; this has to be performed very carefully, making all losses, such as rounding of corners, pressure losses, and expansion and compression, as nearly as possible duplicates of the actual cards, for similar cut-offs. The receiver pressure must be adjusted by "cut and try" and the copious use of the planimeter till the indicated horse power of high and low is practically equal. The variable back-pressure cards must have this pressure established in such a way as to prevent looping in the low-pressure cards; it will be found impossible at light load to prevent very bad looping of both high- and low-pressure cards under constant nozzle pressure conditions, in any compound condensing engine, as the cylinder ratio is too large for non-condensing conditions. This looping is very hard on the engine and on the water rate, and is one of the objections to the constant back-pressure condition, as previously stated. In the case of Corliss geared engines, as in the 59th Street plant, the point of compression is invariable with load, so that the compression line can always be easily located; it is quite near the truth if this line is made hyperbolic, through the point of exhaust closure.

Having established a set of cards for at least four loads for both variable and constant back pressure, the r of each,

$$\frac{(\text{Total L.P. Volume})}{(\text{Cut-off Volume, H.P.})}$$

is measured, and the exact number of pounds of steam indicated at high-pressure cut-off and in high-pressure compression calculated. From these and the indicated horse power, obtained by plani-



A MODERN INSTALLATION OF CORLISS ENGINES, WASHINGTON NAVY YARD.

Four 20 and 38 by 36-in. vertical cross-compound engines, each driving a 500-kilowatt generator; 165-lb. pressure, 100 to 125 degrees superheat; believed to be developing an indicated horse power on 12 lbs. of steam, with 25 to 26 in. vacuum. Wisconsin Engine Co.

ASSUMED CARDS, VARIABLE BACK PRESSURE (= NOZZLE PRESSURE AT TURBINE.)

No.	Total I.H.P.	H.P. IHP Only	Total KW Load	Initial Press. Lbs. Absolute	Receiver Pr. Lbs. per sq. in. absolute	Back Press. sq. in.	Ratio of Expansion r	Missing Water y	Indic. Water Rate/IHP/hr.	Actual Water Rate/IHP/hr.	Actual Water Rate/K.W.H.	Total Water Supplied Lbs/Hr	H.P. Exh. Qual.	Rec. Drains Lbs/Hr	L.P. Adm. Quality	L.P. Exh. Qual.	Lbs Dry Stm. at Exh.
1	5536	3020	4050	210	39.7	7.0	19.2	.474	12.0	17.7	25.9	105000	93.5	4700	98.0	92.6	92900
2	8192	4190	5590	"	46.0	10.0	12.8	.268	12.2	15.5	22.6	126600	92.1	7500	98.0	90.9	108300
3	9836	5080	6710	"	52.2	13.5	9.2	.156	13.6	16.0	23.4	157300	92.0	7900	97.0	90.0	134400
4	10792	5650	7370	"	58.5	18.0	7.0	.087	16.3	17.7	26.0	191100	92.4	8800	97.0	90.6	165100
5	11336	5810	7740	"	64.7	23.0	5.6	.033	18.9	19.5	28.6	221400	93.1	6400	96.0	90.6	194800
				CONSTANT BACK PRESSURE, 16 LBS. ABS.													
6	5676	2995	3875	210	64.7	16.0	12.8	.248	16.3	20.7	30.3	117400	93.3	5500	98.0	93.2	104300
7	8484	4220	5795	"	"	"	9.2	.156	15.6	18.0	26.4	152700	92.5	6900	97.0	91.0	132800
8	10540	5200	7190	"	"	"	7.0	.087	16.5	17.9	26.2	188500	92.5	8500	97.0	90.9	163700
9	12008	6000	8200	"	"	"	5.6	.033	17.9	18.5	27.0	221700	92.8	7100	96.0	90.3	193800

FIG. 2. TABLE OF DATA CALCULATED FROM ASSUMED CARDS AND FORMULA FOR y.

The columns set forth the data and results in about the order in which they appear in the calculations.

metering, the indicated water rate is obtained. Taking the formula for missing water, y, obtained from the original tests, and substituting the values of r from the assumed cards, the missing water fraction is obtained. Multiplying the indicated water rate at each load by $(1 + y)$ gives the actual water rate, from which the curve is plotted. The next thing needed is the quality of the exhaust steam, both of the high-pressure cylinder and of the low; the high-pressure exhaust quality is needed to find the probable trap water which is abstracted between the high- and low-pressure cylinders. The table, Figure 2, gives these values as computed for the 59th Street installation. The method of computing the quality of exhaust steam is simple and fairly accurate.

The heat contents of steam after passing through any cycle is equal to the original total heat, less the work done and the external losses. For the high-pressure cylinder, the external losses consist merely of radiation and conduction, which is less than 1 per cent. The work done in B.t.u. per hour is 2,545 x i.h.p. As an example, take assumed card No. 1 from the table; steam ½ per cent wet at 195 pounds absolute, total heat = 1,195 B.t.u. per pound, 105,000 pounds per hour; 1,195 x 105,000 = 125,475,000 B.t.u. supplied per hour; .01 x 125,475,000 = 1,255,000 radiation; 3,020 i.h.p. x 2,545 = 7,690,000 work done; 1,255,000 + 7,690,000 = 8,945,000. Sub-

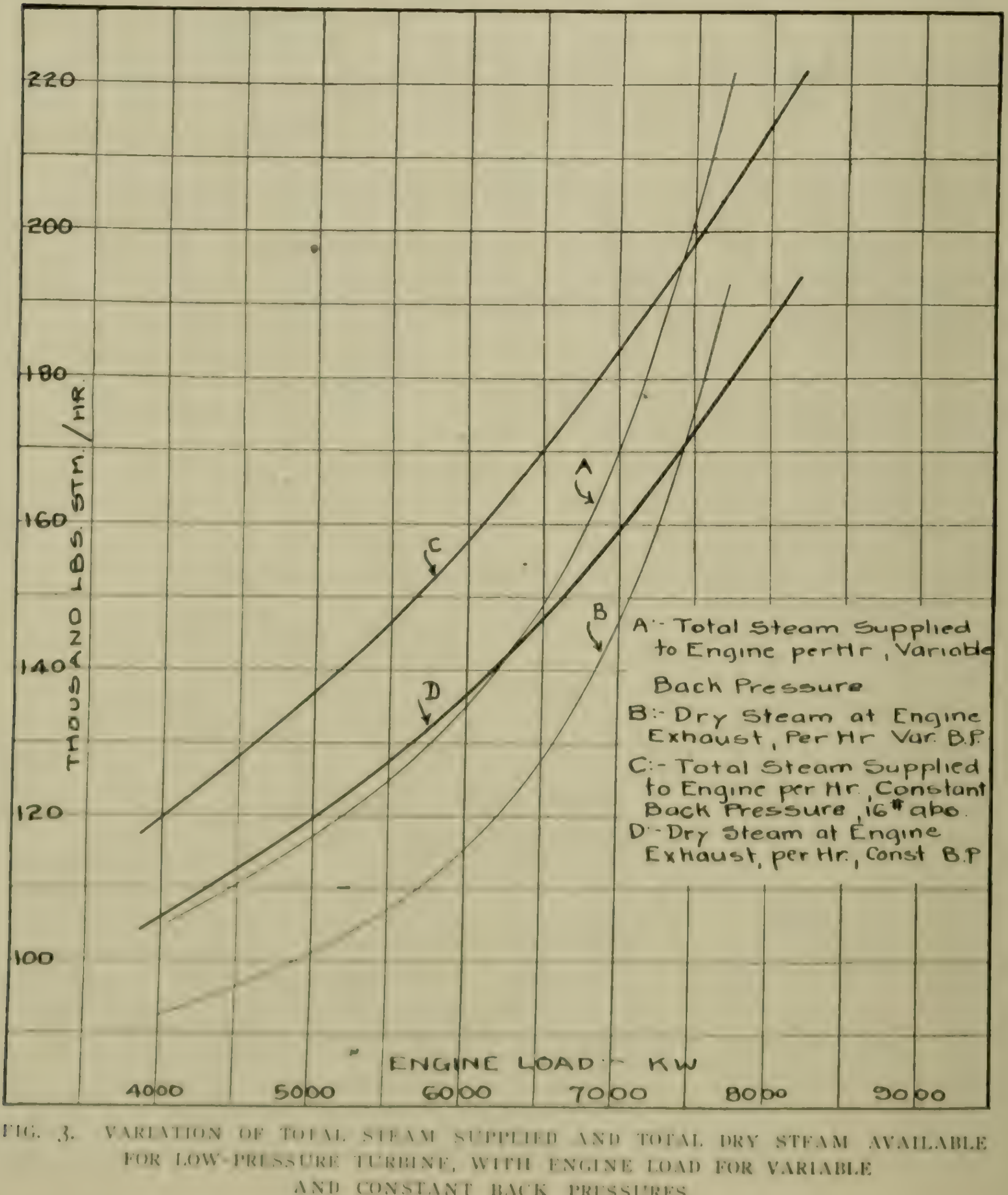


FIG. 3. VARIATION OF TOTAL STEAM SUPPLIED AND TOTAL DRY STEAM AVAILABLE FOR LOW-PRESSURE TURBINE, WITH ENGINE LOAD FOR VARIABLE AND CONSTANT BACK PRESSURES.

tracting 8,945,000 from 125,475,000 leaves 116,530,000, which divided by 105,000 gives 1,110 B.t.u. per pound.

At a receiver pressure of 39.7 pounds absolute, 1,110 B.t.u. per pound corresponds to a quality of 93.5, and similarly for the other loads.

The quality at low-pressure exhaust is obtained in the same manner, only the receiver drip heat must also be taken out; and the radiation and condition losses amount to nearly 2 per cent; using the same card as an example we have 1,195 × 105,000 = 125,500,000 B.t.u. per hour supplied; 2 × 125,475,000 = 2,510,000 radiation. It is probable that the receiver will send the steam to the low-pressure cylinder not better than 98 per cent quality, so we shall have going to the low-pressure cylinder 105,000 × (93.5 + 2) = 100,300 pounds, and 4,700 pounds drips removed. Receiver pressure 39.7 pounds absorption, heat of drips will be 236 B.t.u. per pound.

Then we have 4,700 × 236 = 1,110,000 B.t.u. per hour drip loss. Total i.h.p., 5,936 × 2,545 = 15,100,000 B.t.u. per hour + 1,110,000 + 2,510,000 = 18,720,000. 125,500,000 — 18,720,000 = 106,780,000 B.t.u. per hour ÷ 100,300 = 1,065 B.t.u. per pound.

At 7 pounds absolute back pressure, this corresponds to a quality of 92.6 per cent. Consequently. we shall have at this load, available for use in a low-pressure turbine, 100,500 × 92.6 = 92,900 pounds of dry steam at 7 pounds absolute pressure. Performing this for all the cards, we get curves of total dry steam available for low-pressure turbine at all loads, Figure 3.

For these conditions a turbine could be obtained with guaranteed water rates as shown in Figure 4. Picking out the loads of engine and turbine at any given total dry steam quantity, and dividing by the original total steam supplied, we get the new combined unit water rate, plotted in Figure 5. The turbine builders allow a 10 per cent margin in their guarantee, so the result shown by the curve could probably be bettered. In the case of the 59th Street installation, it was bettered by practically one pound per kilowatt hour in the unit water rate. Part of this was due to the fact that the loss of pressure between engine exhaust and turbine nozzle was actually only 0.65 pound, whereas the calculations and assumed cards were all based on a loss of 2 pounds. This meant an increase of engine power amounting to about 305 indicated horse power without increasing the steam supply.

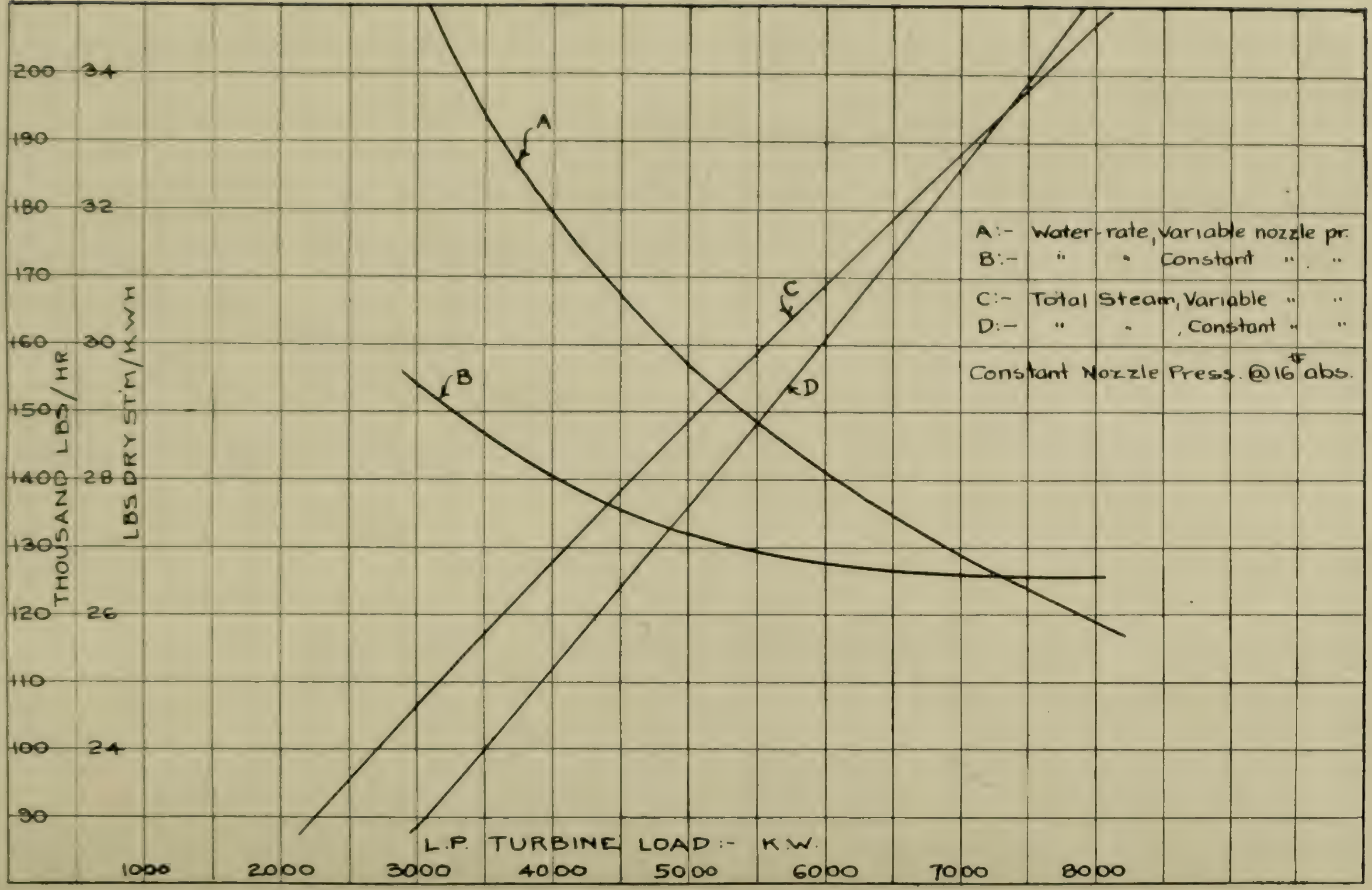


FIG. 4. VARIATION OF WATER RATE AND TOTAL DRY STEAM REQUIRED WITH TURBINE LOAD.

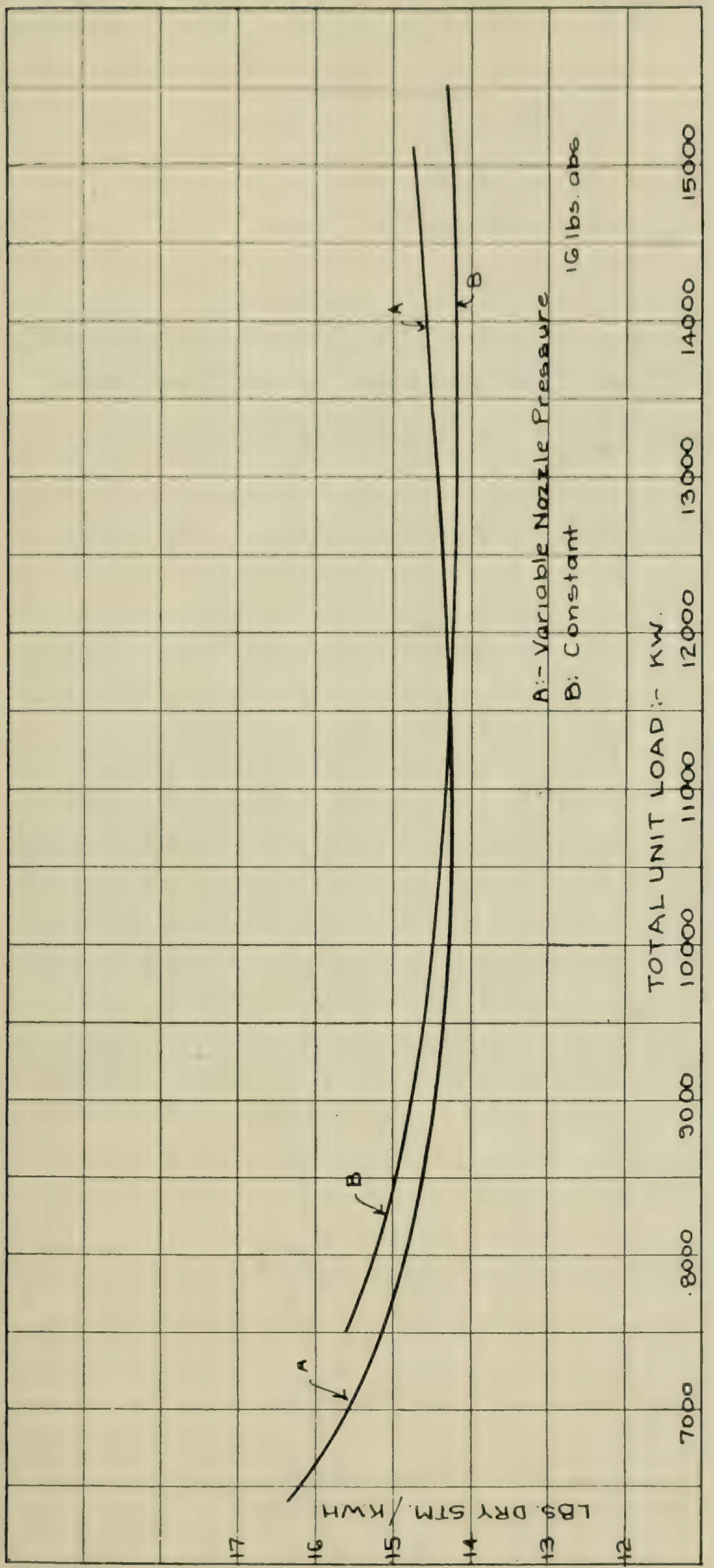


FIG. 5. COMBINED UNIT WATER RATE.

Some of this extra work shows its effect on the exhaust steam as moisture, but there is nevertheless quite a saving.

These curves show what may be done with a large, economical compound Corliss engine; but we need to know the possibilities of a smaller engine. As an example, let us take a 500 horsepower compound high-speed engine, about 18 x 36 x 16 inches, turning up about 250 r.p.m., piston valves, automatic governor. For brevity, we will take only the full rated load condition, supposing it to be the most economical load.

Let initial

steam be 190 pounds, about 1 per cent. wet, vacuum 27 inches, cut-off ½ stroke in high-pressure cylinder at 500 brake horse power, cylinder ratio about 4 to 1. We should get an indicated water rate of 14 pounds per horse power per hour; missing water.

$$y = 120 \frac{1 + r}{d\sqrt{np}} = 120 \frac{1 + \beta}{18 \sqrt{250 \times 195}} = .275.$$

Actual water rate will then be 1.275 × 14 = 17.85. With .90 mechanical efficiency this will give 19.83 pounds per brake horse power per hour = 27.4 pounds per kilowatt hour at 97 per cent generator efficiency.

Refiguring for con-condensing operation in conjunction with a low-pressure turbine, we should have about ¾ cut-off for full load, (500 brake horse power or 556 indicated horse power, or 352 kilowatts, back pressure 16 pounds absolute), r approximately 5.3.

$$\text{Taking } y = 120 \frac{d \sqrt{np}}{1 + r} \text{ we have } y = .192.$$

Indicated water rate approximately 18 pounds per horse power per hour; missing water at .192 and mechanical efficiency at .90, gives 21.5 pounds per indicated horse power per hour; actual water rate, or 23.9 pounds per brake horse power per hour, equivalent to 33.1 pounds per kilowatt hour at 97 per cent generator efficiency, 11,950 pounds total steam per hour.

Quality at exhaust will be 92.1 figured as previously, giving 11,010 pounds dry steam for turbine at 16 pounds absolute. A 400-kilowatt maximum rating machine would do a kilowatt hour on 31 pounds steam at this pressure; this would give 356 kilowatts additional output, with a unit water rate of 16.87 for a total output of 708 kilowatts.

There are hundreds of industrial plants where this increase of power and decrease of water rate, by way of low-pressure turbines, would be the easiest way out of a tight situation, for there are many advantages besides first cost and economy to be considered. In the majority of cases, increase of building is unnecessary for the addition of the turbines, saving an expenditure of possibly 35 per cent of the required outlay for machinery; the new auxiliaries are merely substituted for the old engine auxiliaries, occupying in general no more space (due to improved design in the latest machines). A high-pressure turbine would occupy additional space over the low-pressure machine, on account of adding another set of auxiliaries, and might force the erection of additional building, for it is a fact that since the use of high-speed engines and turbines has become general for moderate powers, it is the boilers and auxiliaries that determine the space required. Roughly, the auxiliaries will occupy a flooring space one and one-half times as great as the unit served. And the additional piping required, (practically duplicating the engine equipment in that respect) would also be likely to make more building room necessary, in the case of the high-pressure turbine or engine added.

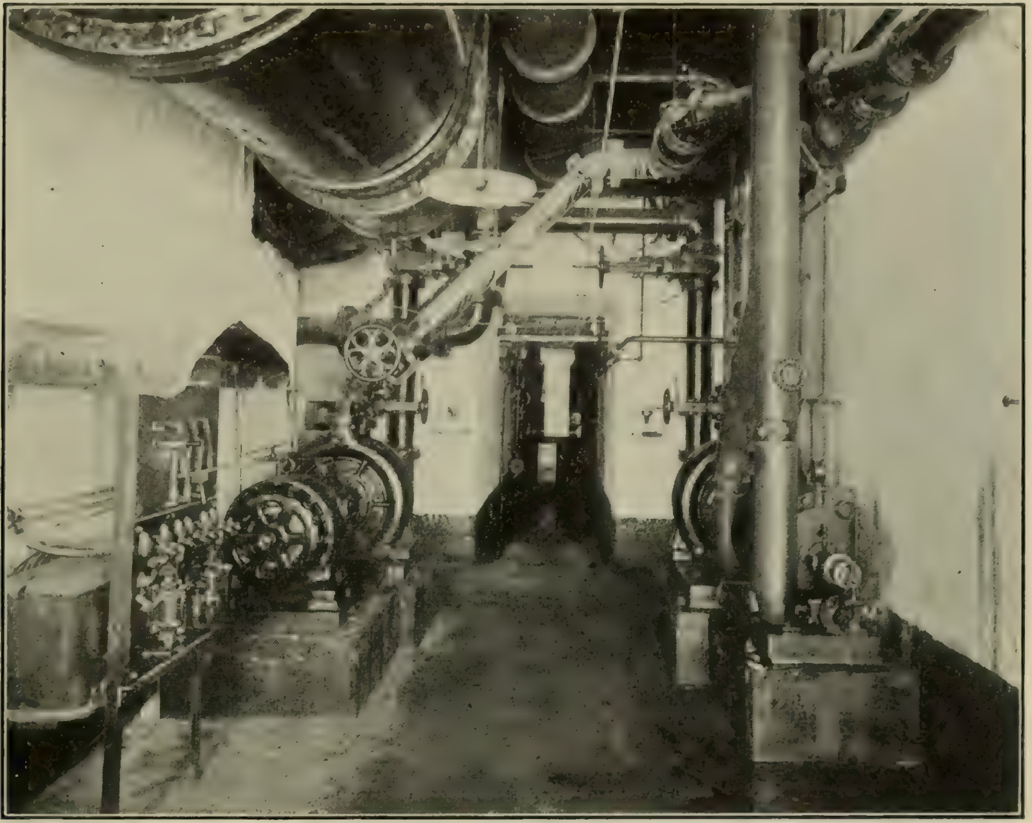


FIG. 6. HOT-WELL PUMPS FOR 15,000-KILOWATT ENGINE-TURBINE UNIT.
Only one pump is used; the other is reserve. Comparison with the 36-in. circulating-water pipe overhead shows the small size of these pumps.

The extra piping for a low-pressure turbine is comparatively small; for, although it is large size, it is made as short as possible by putting the turbine as close against the engine as may be. The advantages from these points of view are perfectly obvious and do not need elaborating—always remembering that the combined unit is *not* in general proposed for initial installation, but chiefly to add power to reciprocating plants already installed. To show more forcibly the influence that recent designs have had on the size of auxiliaries, Figure 6 shows the hot-well pumps used for removing condensation from the condenser. They are two-stage turbine pumps, driven at 1,200 r.p.m., one by a 20 horse-power steam turbine, and the reserve pump by a motor. The whole pump could almost be put inside the circulating water pipe above it. This type of pump requires no attention but lubrication; and wear is imperceptible. The circulating pump engine is shown in Figure 7; the pump can just be seen beyond the engine. This outfit consists of a 500 horse-power American Ball Engine, angle compound, and a 30-inch Worthington centrifugal pump, and occupies a floor space of about 18 x 16 feet, which floor space was completely occupied by the vertical Corliss-driven reciprocating pump originally serving the engine; the original pump was 28 feet high, the new pump is but 10 feet. Of course, this is rather an extreme. At another plant, a 14 x 14-inch high-speed engine driving an 18-inch centrifugal pump is doing the same work as the old pump at 59th street, and occupies a floor space of 10 x 12 feet, being 8 feet high. These floor spaces include passage room around the machines. A

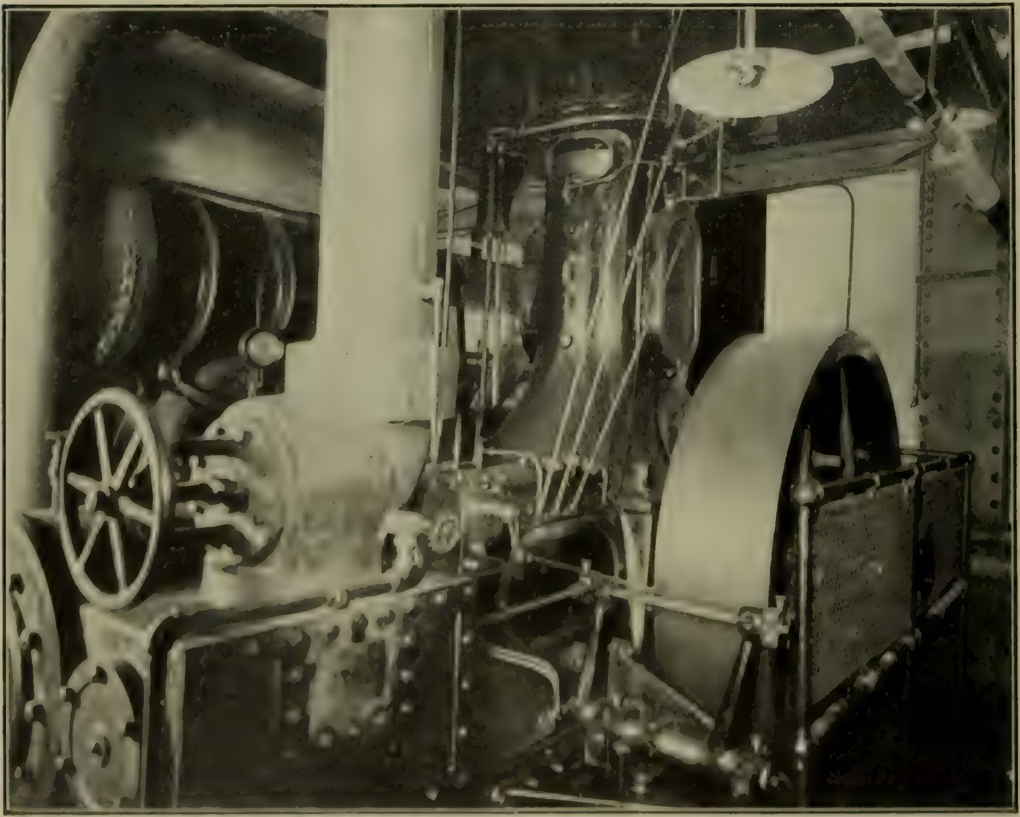


FIG. 7. CIRCULATING-WATER PUMP FOR 15,000-KILOWATT COMBINATION UNIT. The pump and engine occupy the same floor space and one-third the same height as the original 18 in. reciprocating pump supplying the engine only.

still smaller installation could be made if a turbine-driven pump were used; this, for the 30-inch size, would occupy a space of 19 by 8 feet and 6 feet high.

All the computations up to this point have been made on a basis of saturated steam supplied to the engine. But there is one easy way of materially adding to the efficiency—by superheating. Nearly all plants would stand a moderate degree of superheat, say not more than 100 per cent, without trouble from cast-iron fittings or lubrication. Another point in favor of moderate superheat, or what amounts to the same thing, reheating, is that the low-pressure turbine suffers very materially in water rate if fed with wet steam, and it is a very difficult matter to remove the moisture from the engine exhaust and it is practically impossible to remove the last 1 per cent without reheating. The saving is practically all made in the first 75 per cent of superheat at the engine throttle. The saving can be calculated approximately. As soon as enough superheat has been added, so that the steam is always dry in the cylinder, that portion of the missing water which is condensation will practically disappear; for as soon as the cylinder is entirely dry, the surface resistance to transmission of heat is enormously increased, so that very little heat transmission per cycle occurs. This removes the chief loss from moisture. The leakage past valves and piston is changed from water leakage to steam leakage, under superheat, consequently the leakage is cut down to about 1/10 or 1/20 of the leak with saturated steam (since the viscosity of water is so low at temperatures above 212 degrees, and the specific volume of water is so much less than that of steam). So that of the water missing with saturated-steam condition there would be only 8 to 10 per cent with superheated steam.

Refiguring one case of the 15,000 kilowatt engine-turbine combination—No. 3, Figure 2—for superheated steam, 150 degrees superheat at throttle, all other conditions the same.

$y = .156 \times .10 = .016$ under superheat.

Actual water rate $13.6 \times 1.016 \times \frac{2.19}{2.47} = 12.3$.

2.19 = sp. vol. sat. steam at 210 pounds.

2.47 = sp. vol. super. steam at 210 pounds.

B.t.u. supplied $= 12.3 \times 9{,}836 \times 1{,}259 = 152{,}000{,}000$ per hour.

Radiation, 1 per cent, 1,520,000 B.t.u. per hour.

Horse power work, $\frac{12{,}940{,}000}{14{,}461{,}000}$ B.t.u. per hour.

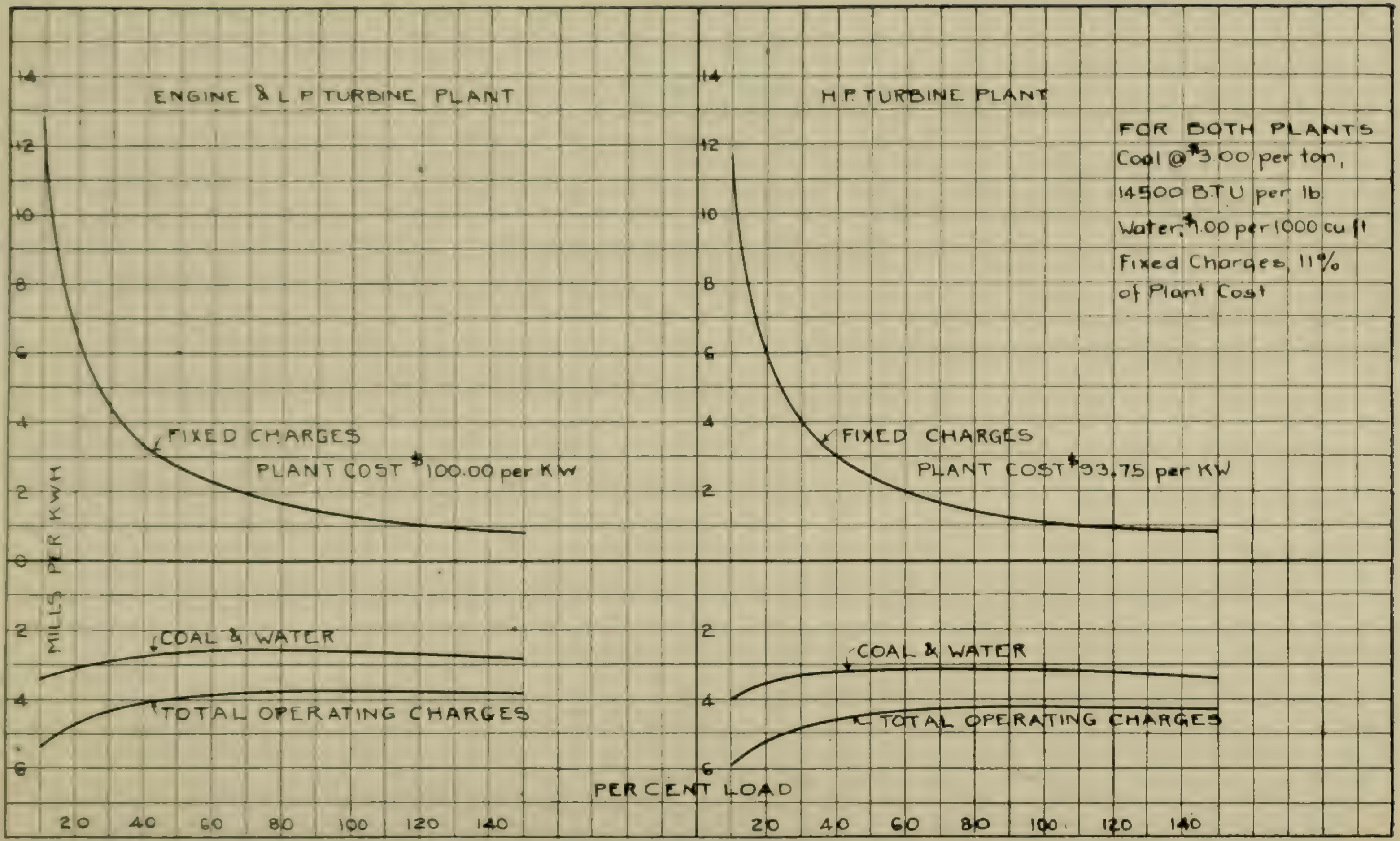


FIG. 8. COST OF POWER FROM HIGH-PRESSURE TURBINE INSTALLATION AND ENGINE-TURBINE INSTALLATION. Courtesy of Mr. H. G. Stott.

$$\text{Leaving } \frac{137,640,000}{121,000} = 1,140 \text{ B.t.u. per pound at 52.2 absolute.}$$

This gives a quality of 96.5. Reheating to 100 degrees superheat again requires (1,225 — 1,140) × 121,000 = 10,280,000 B.t.u., or the equivalent of 8,180 pounds live steam, considering the hot water drained away from the reheater coils as recovered for feed water, since it is clean.

This leaves a quality at low-pressure exhaust of 96 per cent, figured as before. The turbine will have available 116,200 pounds of dry steam, which will be used at about the same water rate as the amount available with saturated steam, since the pressure is the same, giving an output of about 4,200 kilowatts on the turbine. The resulting unit water rate is, therefore,

$$\frac{121,000 + 8,180}{6,710 + 4,200} = 11.9 \text{ pounds per kilowatt hour.}$$

This amounts to a saving of 12 per cent. But all of these calculations on saving by superheat are very uncertain.

The point which remains to be considered is alteration of design of the engine to suit the requirements of operation as the high-pressure member of a combination unit, and is summed up in four points: reduction of condensation missing water; reduction of leakage; higher speeds in large sizes; and better lubrication.

Superheat will eliminate the condensation and most of the leakage; poppet valves are practically entirely tight, and are the only valve suited for superheat; it follows that the poppet valve in some form must become the standard valve. New piston packings will have to be designed, probably with more parts and more separate narrow sliding surfaces—multiple rings, perhaps. Higher speeds point to single-acting engines, although Americans have never looked upon these with much favor. The Germans have been very successful with their engines, getting much better water rates in smaller sizes. Their favorite type is poppet-valved throughout, either horizontal or vertical, and valves driven by a geared lay shaft. In England several builders (notably Willans) make very successful single-acting engines with very high speeds, and very good water rates. It looks as if the trend would be toward some hybrid design, made up of the best features of both German and English types. The only field in which the large reciprocating engine is solidly entrenched, and for which it must now be designed, is for high-pressure, non-condensing conditions, either where exhaust steam is used for heat or industrial purposes, or for use with low-pressure turbines. There are some cases, chiefly in manufacturing plants, and also in power plants, where the load factor is over 50 per cent, in which an initial installation of high-pressure engines and low-pressure turbines would be the cheapest way to produce power, because the low operating cost more than offsets the high first cost. Total power cost is made up of two portions; fixed charges and operating charges.

Figure 8 shows cost of power from a high-pressure turbine installation and an engine-turbine combination as presented in a paper before the American Institute of Electrical Engineers by Mr. H. G. Stott, whose kind permission has allowed the use of the curves in this connection. This shows clearly how the increasing influence of fixed charges at low load factor offsets the saving in coal and water by the more economical combination unit. The arrangement of the curves allows of the use of any operating charge as altered by different costs of coal and water, with the same plant cost. With the condition assumed, at 35 per cent load factor, the power cost from both types of plant is the same. Above this point, the combination type is cheaper; and below, the turbine alone is cheaper.

COSTS OF MACHINE-TOOL OPERATIONS IN STEAM-ENGINE MANUFACTURING.

By Wm. O. Webber.

Mr. Webber's cost data are gathered within recent years from his own experience in the management of machinery-building works in the eastern United States. Careful reconsideration of the figures, and comparison with like costs in other shops, shows that any improvement in tools since Mr. Webber's tables were compiled is about offset by rise in wages, so the data correctly represent average present performances. Special interest attaches to Mr. Webber's testimony on pages 733 *et seq.* to the improved efficiency brought about by attention to some of the "Twelve Principles" laid down by Harrington Emerson in the series of articles now appearing elsewhere in these pages.—The Editors.

AN intimate and personal knowledge of the different processes and methods of doing machine-tool work is very essential to the evolution of a proper system of piece and premium work. It is a fatal mistake to make a price so large at first as to necessitate or even to tempt a cutting down at some later period, as this always makes trouble and creates a feeling of uncertainty and suspicion on the part of the employee. It is a great deal better to make the first price so small that you practically have to guarantee the average day's wages for that class of work, in order to get the employee to make a strenuous effort to better it.

In making such prices it is a fatal mistake also to jump at a conclusion or to guess at the price; the more intelligent way is mentally and personally to go through the several forms of operations upon the identical piece of work under question, and to estimate carefully the time necessary to set the piece in the machine, to calculate the square inches of surface to be machined and the number of cuts required to complete the machining, the feed which can be carried for the respective cuts, and the time necessary to accomplish the given results, and then to convert these data into an average cost per hour for the kind of labor required.

Some results obtained experimentally in various classes of metal-cutting work are noted in the accompanying tables. The first of these tables, on page 730, shows machining costs on connecting rods for small, simple horizontal engines, where the work was done in lots of 20 parts each. Some interesting data were obtained as to the relative cost of forging and machining. For instance, these connecting rods

COST OF MAKING CONNECTING RODS.

Size of Engine.	Forging, Per Piece.	Turning (each) 1 Lathe.	Turning (each) 2 Lathes.	Planing. Fitting.	Planing. Finishing.	Slotting Straps, per Pair.	Planing Straps, per Pair.	Turning Brasses, per Pair.	Assembling per Set of Five.
8 x 12	$1.15	$0.38	$0.26	$1.00	$1.30	$0.21	$0.25	$0.25	$8.50
9 x 12	1.25	0.40	0.27	1.15	1.85	0.21	0.25	0.25	9.00
10 x 12	1.35	0.40	0.27	1.15	1.85	0.23	0.30	0.27	9.80
10 x 15	1.45	0.45	0.32	1.30	2.20	0.26	0.30	0.27	11.20
11 x 15	1.60	0.50	0.35	1.30	2.20	0.27	0.33	0.30	12.25
12 x 16	2.00	0.55	0.36	1.50	2.50	0.44	0.35	0.33	13.80
14 x 16	2.40	0.60	0.42	1.75	2.75	0.50	0.35	0.60	15.50

COST OF MACHINE-TOOL LABOR IN BUILDING CENTRE-CRANK ENGINES.

Size.	Lathe.	Drill.	Planer.	Vise.	Slotter.	Shaper.	Bolt Cutter.	Black-smith.	Total Hours.	Value for Twenty Engines.	For one Engine.
8 x 12	$104.56	$31.44	$40.14	$240.57	$11.87	$14.20	$4.22	$29.25	2,405.00	$537.57	$26.83
9 x 12	116.88	30.18	54.09	279.81	14.50	16.66	4.22	31.50	2,813.00	617.05	30.85
10 x 12	122.40	51.42	61.83	283.05	12.87	11.98	4.55	31.50	3,090.00	655.71	31.25
10 x 15	138.56	48.12	59.31	283.59	14.00	17.08	5.20	33.75	3,365.5	684.84	34.24
11 x 15	159.20	51.00	65.61	331.56	12.87	18.61	5.20	33.75	3,974.35	695.85	34.79
12 x 16	174.88	76.68	72.36	350.64	21.25	46.15	5.52	36	4,707.50	807.40	40.37
13 x 16	168.80	54.60	82.98	405.27	23.25	22.27	5.52	38.25	4,530.00	906.00	45.30
14 x 16	216.16	88.24	94.04	450.18	25.00	49.46	5.84	40.50	5,350.00	1,070.00	53.50

PERCENTAGES OF LABOR AND COSTS. CENTRE-CRANK ENGINES.

8 x 12	21.90	6.60	8.45	50.5	2.48	2.98	0.88	6.10—99.89
10 x 12	21.00	8.90	10.70	48.7	2.21	2.06	0.78	5.42—99.77
12 x 16	22.20	9.80	9.20	44.7	2.71	5.90	0.70	4.60—99.81
Average	21.70	8.43	9.45	47.9	2.46	3.64	0.75	5.37—99.76

This table shows the percentage of labor and costs for three different sizes of these engines, from which it will be seen that the percentages for the different classes of work are very uniform. This is also true of side crank engines of the same general type with hooded bed and overhung cylinders.

were made largely from round iron with ends upset to form the rectangular parts to which the brasses and straps were attached, the rods being then turned a double taper from the center, reducing toward each end. Forging at the price given (which included the straps and keys for each size rod) left a surplus of stock to be turned off in the lathe between the square ends, or (in shop parlance) the "stub ends." It was therefore determined to forge the rods more closely to the finished size; but the saving in turning was more than made up in the extra cost of blacksmithing, lathe work costing only about 19 cents an hour as against the cost of 45 cents per hour for blacksmith, helper, and fire.

Some more interesting figures were obtained in different methods of doing the work, that is machining straps on the shaper as against doing the same work on a planer, and milling brasses on a milling machine, as against doing the same work on a shaper.

It will be noted also that there are two prices given for lathe work, the price for two lathes being cheaper than that for one lathe. In this latter case the workmen would rough out on the one lathe and finish on the second. This difference of price in connection with the use of more than one tool is emphasized in the turning of crank shafts for these same centre-crank engines for instance.

In roughing out the workmen could easily run two lathes or in finishing it paid him to hire an apprentice at a fixed rate to assist him in running the three lathes.

COSTS OF OPERATIONS ON CENTRE-CRANK SHAFTS.

	Turning (each)			Turning	Slotting	Key
Size.	1 Lathe.	2 Lathes.	3 Lathes.	Discs.	Discs.	Seating.
8 x 12	$1.80	$1.15	$1.00	$0.35	$0.31	$0.20
9 x 12	1.80	1.15	1.00	0.35	0.31	0.23
10 x 12	2.00	1.40	1.23	0.40	0.33	0.24
10 x 15	2.50	1.65	1.44	0.45	0.40	0.27
11 x 15	2.60	1.70	1.49	0.50	0.40	0.30
12 x 16	3.00	2.20	1.75	0.60	0.45	0.34
14 x 16	3.15	2.40	2.00	0.70	0.50	0.38

A large saving in cost was made by tapping the holes which had to be threaded in the cylinders by machinery at the same time that the holes in the cylinders were being drilled; for instance, in a 10 by 12 cylinder there are sixteen holes which average ¾ of an inch and sixteen small holes for attaching the sections of the jacket to the cylinder. The price for drilling all of these holes was 32 cents, or a cent per hole; nineteen of these holes could be tapped on the machine at a cost of 19 cents, or 1 cent per hole, which is very much cheaper than they could be tapped by hand afterwards.

TIMES OF OPERATIONS ON SHAFTS OF VARIOUS SIZES.

Diameter of Shaft, Inches.	Number of Hours for Turning and Key-Seating Shaft 1 foot long.	Diameter of Shaft, Inches.	Number of Hours for Turning and Key-Seating Shaft 1 foot long.	Diameter of Shaft, Inches.	Rough Weight of Engine Shaft per Foot, in pounds.	Diameter of Shaft, Inches.	Rough Weight of Engine Shaft per Foot, in pounds.
2⅜	1.23	6½	2.98	2⅜	18.17	6	107.21
2⅝	1.33	7	3.22	2⅝	21.80	6½	124.71
2⅞	1.42	7½	3.42	2⅞	25.73	7	143.50
3⅜	1.62	8	3.51	3	27.87	7½	163.63
3½	1.66	8½	3.84	3⅜	34.67	8	185.05
3⅝	1.71	9	4.03	3½	37.10	8½	207.76
3⅞	1.80	9½	4.22	3⅝	39.61	9	231.89
4	1.85	10	4.41	3¾	42.19	9½	257.29
4¼	2.02	10½	4.59	3⅞	47.60	10	283.92
4⅜	2.07	11	4.78	4	50.40	10½	311.92
4½	2.12	12	5.16	4¼	56.44	11	341.43
4⅝	2.17	13	5.54	4⅜	59.53	12	404.04
4¾	2.23	14	5.90	4½	62.69	13	472.08
4⅞	2.29	15	6.29	4⅝	65.94	14	545.16
5⅛	2.37	16	6.67	4¾	69.28	15	631.68
5⅜	2.49	17	7.04	4⅞	72.68	16	715.68
5½	2.54	18	7.42	5⅛	79.80	17	806.40
6	2.80			5⅜	87.08	18	900.48
				5½	91.05		

It may seem strange to make piece work prices on general laboring, but unloading foundry sand was done for 10 cents per ton, whereas 12 cents per ton was paid for unloading coal, because it was dirty, and 13 cents per ton was paid for unloading pig iron because of the wear and tear on the leather mittens or "hand holds" which the men were obliged to wear in doing the latter work.

Too much cannot be said regarding the economies secured by providing proper facilities for doing work. At one plant where I took hold of this subject, they had always been behind in the matter of common grate bars as furnished for horizontal tubular boilers. In fact, the plant was usually three weeks to three months behind in shipping these grates, so that it got to be a scandal for a consumer to receive a car load of boilers and accessories, to have time enough to unload the boiler, set it up, get it bricked up and all piping connections made, and then have to wait three or four weeks before getting the grate bars.

Upon investigating the conditions it was found that the grate-bar patterns, which were of wood, were old, twisted, and did not draw properly. The flasks used for moulding these grates were in similar condition. Of the grates moulded during any given date fully 35 per cent were lost in casting, and it was almost impossible to get a moulder to undertake the "job" of moulding grates, so that each person was given some grates to mould in order to distribute the curse. I went to work and had an entirely new set of grate-bar patterns made of iron, finished all over, rusted and waxed, with two sets of holes tapped for rapping and draw irons. I then had a set of hinged cast-iron flasks made, just taking three pieces of double-bar grate. We gave all these grates to one moulder, paying him 4½ cents for a 36-inch grate. In a very short time he was making from $3.50 to $4.50 per day, and the loss of grates in casting did not amount to 5 per cent. It did not pay to have moulders doing laboring work, so that we evolved the scheme of having a laboring gang come in about 9 o'clock in the evening, shake out all the flasks, and take the red-hot castings out of the foundry proper; another laboring gang came in at about 4 o'clock in the morning, and cleaned up each moulder's floor, brought in from the sand sheds fresh sand, which had been properly tempered the day before by machinery, and made up the moulder's floor with a row of properly tempered old and new sand. This same gang brought in the patterns to be used on each particular floor and all the flasks and moulding boards for each particular pattern, all of which were piled symmetrically so that when the moulder

COSTS OF VARIOUS MACHINE OPERATIONS ON STEAM ENGINES.

BEDS.

Size of Engine.	Drilling		Planing.	Babbetting and Putting in Studs.
	Pillow Blocks.	Other Holes.		
8 x 12	$0.12	$0.27	$0.50	$0.90
9 x 12	0.12	0.29	0.50	0.90
10 x 12	0.14	0.29	0.60	1.05
10 x 15	0.16	0.35	0.70	1.15
11 x 15	0.18	0.40	0.80	1.25
12 x 16	0.20	0.45	0.90	1.60

CYLINDERS.

Size of Engine.	Boring		Planing.	Vise Work.	Turning Heads.	Drilling
	1 Mch.	2 Mch.				
8 x 12	$0.76	$0.60	$0.50	$1.15	$0.22	$0.25
9 x 12	0.80	0.64	0.65	1.20	0.25	0.29
10 x 12	0.88	0.70	0.70	1.20	0.30	0.32
10 x 15	0.96	0.77	0.85	1.30	0.30	0.34
11 x 15	1.02	0.82	0.85	1.60	0.35	0.37
12 x 16	1.12	0.90	0.95	1.60	0.10	0.40
14 x 16	1.44	1.15	1.20	2.25	0.60	0.45

PISTONS.

Size of Engine.	Turning.	Drilling.	Bolt Cutter on Rods.	Rings, Turning.
8 x 12	$0.80	$0.12	$0.12	$0.13
9 x 12	0.88	0.15	0.15	0.14
10 x 12	1.00	0.20	0.20	0.15
10 x 15	1.00	0.20	0.20	0.15
11 x 15	1.20	0.20	0.20	0.16
12 x 16	1.25	0.25	0.25	0.17
14 x 16	1.50	0.30	0.30	0.19

SLIDES.

Size.	Planing Top.	Drilling.
8 x 12	$0.00	$0.07
9 x 12	0.40	0.07
10 x 12	0.40	0.07
10 x 15	0.45	0.07
11 x 15	0.55	0.07
12 x 16	0.70	0.08
14 x 16	1.00	0.10

STEAM CHEST COVERS.

Size.	Planing.	Milling.
8 x 12	$0.27	$0.15
9 x 12	0.30	0.17
10 x 12	0.30	0.20
10 x 15	0.32	0.22
11 x 15	0.35	0.25
12 x 16	0.40	0.25
14 x 16	0.50	0.30

It may seem a difficult thing to make piece work prices on painting, including the striping, of such things as engines, but for

Engines 18 x 12 to 10 x 12 the price was $0.80,
10 x 15 to 12 x 16 " " " 0.90,
13 x 16 to 14 x 18 " " " 1.00, including varnishing.

These prices included varnishing also.

arrived he found the pattern he was to work on, the quantity which he was to make chalked on it, the sand and flasks to work with; and as soon as he was through moulding in the afternoon he returned his pattern to the foundry pattern room, re-marked to suit the number of moulds he had made. This was again checked by the foreman of the laboring gang with the number of good castings removed to the cleaning room, a record being kept of the difference between pieces moulded and good pieces secured; this increased the efficiency of that particular foundry fully 33 per cent.

TIME REQUIRED TO TURN, KEY-SEAT, AND BALANCE, PULLEYS, PER INCH WIDTH OF FACE.

Allowance is made for Pulleys in rough, hours and decimal parts of an hour.

Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.	Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.	Diameter of Pulley Inches.	Hours Required to Turn Balance and Key-Seat Pulley 1 in. Wide.
6	.283	54	1.789	100	3.23
8	.346	56	1.852	102	3.29
10	.408	58	1.915	104	3.35
12	.471	60	1.977	106	3.41
14	.534	62	2.040	108	3.47
16	.585	64	2.100	110	3.54
18	.648	66	2.160	112	3.60
20	.711	69	2.220	114	3.66
22	.774	70	2.280	116	3.72
24	.836	72	2.350	118	3.80
26	.899	74	2.41	120	3.84
28	.962	76	2.47	122	3.90
30	1.026	78	2.54	124	4.96
32	1.083	80	2.60	126	4.00
34	1.151	82	2.68	128	4.06
36	1.213	84	2.72	130	4.12
38	1.276	86	2.79	132	4.18
40	1.339	88	2.85	134	4.25
42	1.402	90	2.91	136	4.31
44	1.465	92	2.98	138	4.37
46	1.528	94	3.00	140	4.43
48	1.590	96	3.00	142	4.49
50	1.663	98	3.16	144	4.54

As another instance of economies secured by provision of facilities for doing work, I have quite often had a workman come to me and voluntarily offer to take a certain line of work at a cut in the then prevailing price list, if I would give him certain facilities. In one case such a proposition was made on the condition that I should give the man all of a certain class of work. In this case the workman was planing cylinders, but his planer was not large enough to permit him to plane the largest two sizes handled in that shop. He offered to take all the cylinders at a 10 per cent reduction if I would give him a new planer large enough to take all of the cylinders, and then give him all of the cylinders to do, and this in spite of the fact that the planer which he was then working on was a relatively new modern planer.

COSTS OF VARIOUS OPERATIONS ON STANDARD BOILERS; HAND WORK.

Setting Flues.		Punching and Reaming Flue Holes,
1½-inch and 2-inch flues,	5 cents	30 cents per Hundred
3-inch flues,	6 cents	
3½-inch and 4-inch flues,	8 cents	
6-inch flues,	12 cents	

Chipping Edges of Sheets of Boilers, 4½ cents per lineal foot.
Caulking, 2 cents per lineal foot.
Punching Rivet Holes, 15 cents per hundred.
Riveting Boilers with either steam or hydraulic rivets, 40 cents per hundred rivets, an average day's work being about one thousand ¾-inch rivets.
Stay Bolts, 3¾ cents each for tapping, putting in, and driving.

Premium Work.

I have often found it of material advantage to pay an extra price on an extra production, although it made the average cost of the total output of such a piece more than the average piece-work price. Ordinarily this would not seem to be profitable, but it often happens that the production of two more pieces of a particular part increases the whole capacity of the plant just so much, say 10 per cent, or even 5 per cent, without any increase in the cost of the other parts, with, of course, collateral saving in general expense. It also has a further effect of prodding along other workmen or departments, as among good honest workmen there is an inherent dislike to feel that they are holding back the work or that the output is waiting for them.

A further exemplification of this spirit is shown by the advantages gained in putting up on a large blackboard, so that all of the workmen in the shop can easily see it, the date at which a set of machines was put into the shop, and the date at which they are expected to be completed, and stating the total number of hours in which a previous similar lot was completed. The men invariably want to beat their own record.

EDITORIAL COMMENT

Accident and Conquest.

ANOTHER Zeppelin dirigible has gone the way of its several predecessors (fortunately without loss of life to passengers or crew) and the first commercial aerial transportation enterprise ends almost before it had begun. Those enthusiasts, however, who see the "conquest of the air" in every flight that ends without actual disaster, will be only briefly if at all cast down. They forget that conquest consists not in ability to raid the enemy's country hither and yon, occasionally or even frequently, when his forces are absent, but in ability to occupy that country permanently and securely against any violence the enemy can offer. It is on this point that accidents of the class of the repeated destructions of Zeppelin's ships teach a lesson wholly different from that conveyed by the deplorable, but probably wholly accidental, destruction of the Erbsloeh.

As we have said before in these pages, there is no fundamental reason why the best present aviation records, in any direction, should not be enormously and even indefinitely excelled—under special conditions. There is no fundamental reason why a dirigible airship should not cross the Atlantic—under special conditions. Yet the air would be as far from conquest as ever, because the conditions making up the largest factor in the favorable result are special—accidental or occasional, wholly meteorological—now, and in our opinion always, wholly beyond the control of the aviator or aeronaut.

In our belief, there are several fundamental facts or factors that remove the solution of the problem of "conquest of the air" to an inaccessible distance. These are: First, that all air craft are of necessity extremely frail in comparison with any other form of vehicle used for traffic or transportation; second, that these relatively frail craft must always be subject to an extreme violence of the medium navigated—a violence relatively far greater than that of any other medium practically navigated by man; third, that any serious accident resulting from either the frailty of the craft or the violence of the medium almost necessarily involved wholly fatal results.

These obstacles are of a different order from those that opposed the practical success of the railway or the steamship; and there is not now, as a treasury to draw from, such an enormous unrealized margin of mechanical knowledge as lay ahead of the inventor of the steam engine. Like many other developments heralded as revolutionary, but probably in more limited degree, aerial navigation will serve some few purposes, old or new, better than other agencies. It does not seem likely that any of these purposes will be of much economic importance. It does not seem likely that aerial vehicles can ever be depended upon to perform even these services infallibly. It seems highly improbable that the navigation of the air has any serious meaning for the serious transportation and traffic problems of the world.

The Bureau of Mines.

OUR editorial last month on the Bureau of Mines called forth very interesting comments from some of the leading mining engineers of the United States; but the appointment of Mr. George Otis Smith as acting director of the new Bureau, and the transfer of the entire technologic branch of the United States Geological Survey with its personnel, property, and equipment to the

Bureau of Mines, forestalls further discussion of the subject. In substance, the same work will be carried on by the same men. It is to be assumed, therefore, that the methods, the efficiency, and the scientific standing of the investigations will be unchanged; and there remains only the question whether the change of spirit or purpose, imposed or implied by the act of Congress creating the Bureau, will induce a sympathetic change on the part of mine owners and managers that will in a more or less tangible way influence the results.

It is interesting to note that out of a little more than $500,000 appropriated in total for the Bureau, including salaries, rent and expenses of removal, $310,000 is devoted to the investigation of mine accidents, and under the plans approved by the Secretary of the Interior about two-thirds of this sum will be spent on the maintenance and extension of rescue stations; $40,000 is allotted to the investigation of explosives, $14,000 to the use of electricity in mining, $8,000 to appliances for the prevention of mine accidents, and $5,000 to the examination and codification of mining laws. The other large field of activity laid out for the Bureau is the analysis and testing of coals, lignites, ores, and mineral fuel substances, for which $100,000 is appropriated. One-quarter of this sum will be devoted to inspection of government fuel purchases, and the remainder to chemical, physical, and efficiency investigations of fuels, including the study of lignites and peats and of briquetting.

If money and activity are to be expended in mining investigations under Government direction, the apportionment of most of it to matters connected with coal mining certainly seems expedient; for there undoubtedly the largest remaining opportunity for investigation and improvement is to be found. It is difficult to see how the Bureau could greatly instruct or assist the metal miner or metallurgist. Indeed, in no part of the field is there any close analogy to agriculture, which is carried on by small individual enterprise incapable of making far-reaching investigations. Mining is generally in the hands of large corporations, already energetic in research and in improvement of methods. It is to be inferred that in some other way the Bureau of Mining will contribute to economic advantage and the general good.

THE adjustment of the threatened labor troubles on the Pennsylvania Lines is a happy exhibition of the good wrought by patient conference, and of the power of the Fair Deal to prevail, steadily though quietly, against even the threatened sway of the Big Stick. It is an eminently common-sense adjustment of questions that at one time seemed likely to lead to a great and much-to-be deplored strike. Without abandonment of ideals, without abatement of discipline, the danger has yielded to common-sense and the fair deal. And Ideals, Common-Sense, the Fair Deal, and Discipline, are four of Harrington Emerson's twelve principles of efficiency. The first of these is brilliantly set forth in this issue. The second, Common-Sense, will form the subject of Mr. Emerson's September article.

AN unavoidable interruption, due to the illness of the author, occurs this month in the publication of Mr. Claydon's series on foundry management and foundry costs. It was the author's purpose in this installment to bring together the plans and methods suggested in preceding articles, and show how they operate jointly in a simple and logical system for the prevention of waste and the reduction of expense. The postponement of this concluding article will be for a month only, and it will appear in our September issue.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

POWER PLANT ECONOMIZERS.

CHARTS AND DATA FOR DETERMINING THE EFFICIENCY AND ECONOMY OF ECONOMIZER INSTALLATIONS.

Frank Kingsley—Engineering Record.

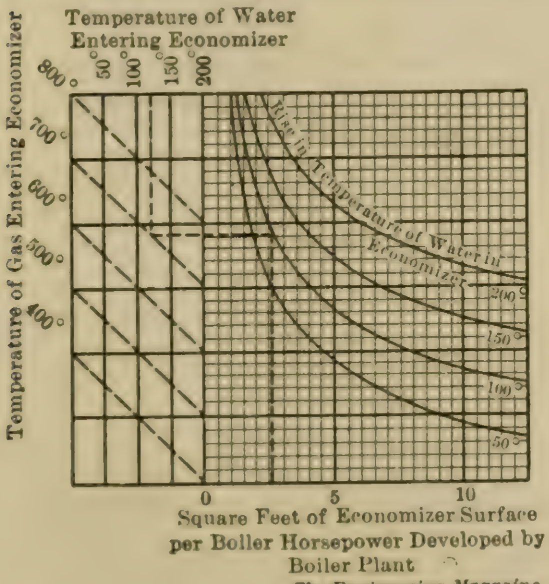
THE charge often made against economizers, that they do not "economize," is refuted by Frank Kingsley in an extremely practical article contributed to *The Engineering Record* for June 4. Mr. Kingsley does not argue that an economizer is always an economical addition to a power plant, but he believes that when properly installed to meet certain conditions it proves to be an exceedingly profitable investment. Notwithstanding the number of factors which enter into the solution of economizer problems, Mr. Kingsley finds the economizer as susceptible of as nearly exact analysis as any other item of power-plant equipment. In a series of charts, which are reproduced on the pages following, he indicates clearly the conditions governing efficient and economical operation of economizer installations.

Since the economizer is simply a means for transferring heat from gas to water within a very limited range of temperature, the rate at which the transfer takes place is equal to the square of the mean temperature difference between the gas and the water, divided by a coefficient of resistance to the passage of heat. This relation may be expressed by the formula $Q=x^2/a$, in which Q is the number of B. th. u. transferred per hour per square foot of surface in the economizer, and x is the mean difference in temperature between the gas and the water. On account of the limited range of temperature through which the economizer operates, the arithmetical mean value of x may be used for the sake of simplicity without danger of serious error. The value of the coefficient a is close to 150 for all well designed, modern economizers, variations from this value being usually less than 10 per cent., although in old, carelessly set economizers it may rise as high as 200.

"The test of an economizer is, manifestly, the determination of the coefficient of resistance. It fixes the relative economy, and the actual ability to absorb heat, under all reasonable variations of gas and water temperature. In order to obtain it, the entering and leaving temperatures of gas and water must be averaged for a considerable period of steady load. The area of the economizer and the weight of water passing through it per hour must also be determined." From these data the coefficient of resistance may be determined from the formula

$$a=\frac{A\ \ [(T_1+T_2)-(t_1+t_2)]^2}{4\qquad N(t_2-t_1)}$$

where T_1 and T_2 are the entering and leaving temperatures of gas, t_1 and t_2 the entering and leaving temperatures of water, N the pounds of water fed to the boilers per hour, and A the area of the economizer in square feet. This formula, of course, cannot be used to determine what a proposed economizer will do in operation. The number of variables affecting economizer operation is so great as to preclude the use of anything but graphical expression of the data on which such a determination can be based.



The Engineering Magazine

FIG. I. AREAS OF ECONOMIZERS REQUIRED UNDER VARIOUS CONDITIONS.

The most frequent economizer problem is the determination of the area required to produce a given increase in feed-water temperature, the temperatures of gas and water entering the economizer being known; in certain cases the area may be specified and the rise in feed-water temperature is to be determined. The areas of economizers are usually expressed in square feet per horse power developed by the boilers. Since variations in feed temperature and steam pressure cause little difference in the weight of water required per boiler horse power, the boiler horse power serves also as a measure of the weight of water passing through the economizer; by assuming a steam pressure of 160 pounds and a temperature of water entering the economizer of 100 degrees, the chance of serious error becomes negligible. The remaining factor required to determine the rate of heat absorption and the necessary area for any entering gas temperature and rise in water temperature, namely, the final temperature of the gas as it leaves the economizer, is determined by the fact that, in practice, the drop in temperature of gas passing through the economizer is invariably close to twice the rise in temperature of the water.

The curves in Figure 1 are based on these considerations. The lines at the left of the diagram are merely a graphical device for subtracting the temperature of the entering water from that of the entering gas. From this initial difference, the mean difference and also the heat units absorbed follow for any particular rise of feed temperature; the rate of heat absorption per horse power and the temperature rise determine the necessary area per horse power. The method of using the diagram is shown in the dotted line: a line is projected downward from the point of entering water temperature to intersect the line of entering gas temperature, and from the point of intersection a horizontal line is drawn to the curve of feed temperature rise. The necessary area of economizer per horse power is shown immediately below the latter point of intersection.

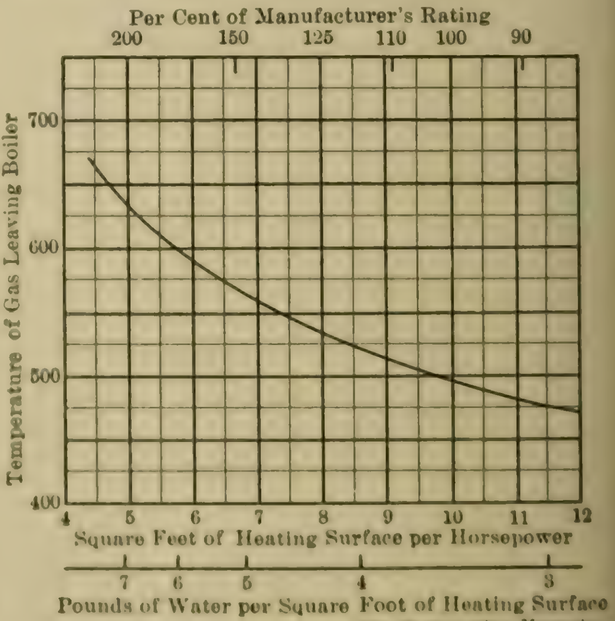


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FIG. 2. APPROXIMATE FLUE TEMPERATURES OF STEAM BOILERS.

The temperature of gas entering the economizer is a factor which cannot be determined positively for a proposed plant. It is largely a matter of extent of heating surface under good operating conditions and fair fuels, and its estimation must be based largely on experience. The curve in Figure 2 showing approximate flue temperatures is drawn through a large number of plotted results of actual boiler tests. With exceptionally good fuels the temperatures may be as much as 50 degrees lower than those shown; with extremely low-grade fuels or careless firing they may be as much as 75 degrees higher.

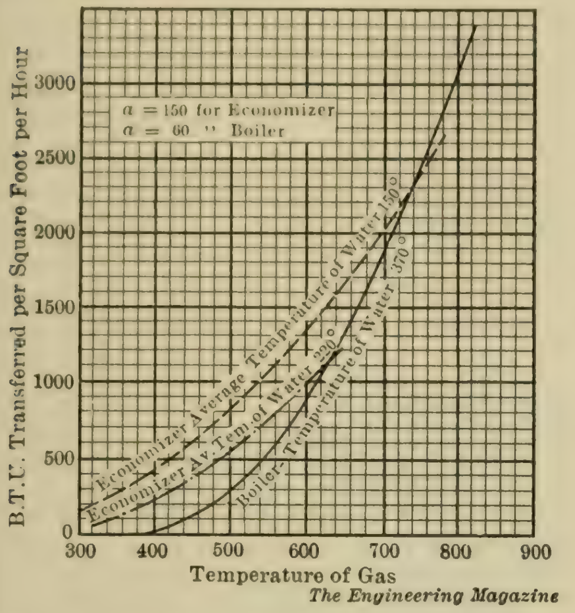

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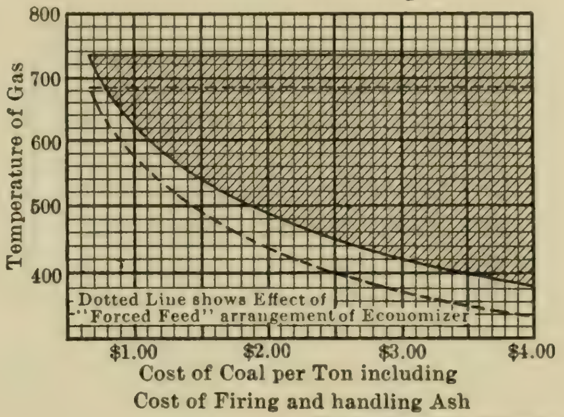
FIG. 3. RELATIVE EFFICIENCY OF BOILERS AND ECONOMIZERS.

Manifestly it is desirable to instal economizers only where they can absorb more heat than the same amount of boiler heating surface. Absorption of heat is more efficient in the economizer than in the boiler only under certain conditions. Boiler heating surface can have a coefficient of resistance as low as 60, less than half that of the economizer. The thick, soot-covered, cast-iron tubes of the economizer are able to compete with the thin sheets of boiler heating surface only because of the low temperature of the water they contain. However, with an average water temperature of say 370 degrees, due to a steam pressure of 160 pounds, the boiler is less efficient at low gas temperatures because the "temperature head" between gas and water is much less than for the economizer, where the mean water temperature may be 150 degrees, or even less.

This is shown in Figure 3, where the heat units absorbed by 1 square foot of boiler surface with a water temperature of 370 degrees and a coefficient of resistance of 60 are shown for various gas temperatures. The two dotted curves show the heat units absorbed per square foot of heating surface by economizers with coefficients of resistance of 150, containing water at average temperatures of, respectively, 150 and 220 degrees. At all gas temperatures below 740 degrees, the economizer of low water temperature absorbs more heat units than the boiler. With gas temperatures between 400 and 500 degrees the economizer absorbs from three to ten times as much heat as the boiler, and since flue temperatures below 500 degrees are common, the conclusion is inevitable that many power plants now in existence would have been better off had they dispensed with some of their boilers and installed economizers in their place.

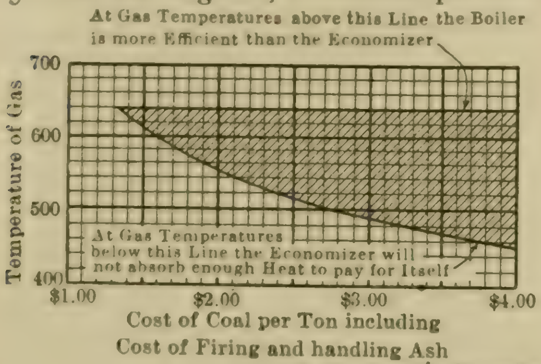


The Engineering Magazine

FIG. 4. SHADED AREA GIVES LIMITS OF GAS TEMPERATURE FOR PROFITABLE ECONOMIZER OPERATION WITH WATER AVERAGING 150 DEGREES.

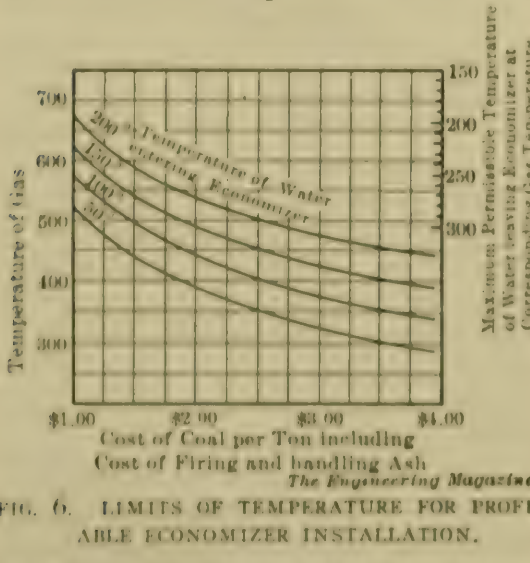
The installation of an economizer is not always a profitable investment, however. The economizer may be vastly more efficient, relatively, than the boiler, and yet not absorb enough heat to warrant the first cost of its installation. "An economizer of ordinary type is worth in place about $1.15 per square foot of heating surface. The building space it occupies is worth about 10 cents more. The interest and depreciation may be taken at 12 per cent., or, say, 15 cents per year. Repairs amount to 3 cents and power to drive scrapers 2 cents. The fixed charges are, therefore, 20 cents per year; and if profit be taken at 4 per cent., or 5 cents more, it may be generally assumed that an economizer which does not earn about 25 cents per square foot per year is not a profitable investment."

In Figures 4 and 5 are shown the limits of gas temperature within which economizers carrying water at, respectively, 150 and 220 degrees, at various prices of coal per ton will absorb enough heat units to make their installation profitable. The curves are based on a 10-hour working day and a nearly constant normal load, but they would also apply roughly to power plants with variable loads at 30 per cent. power factor. The dotted line in Figure 4 shows the effect of the forced-feed arrangement, in which the water and gas move in opposite directions and the hottest water leaves the economizer at the end at which the hottest gas enters This method of operation obviously prevents the consideration of temperature differences based on a mean water temperature, and a separate set of curves for forced-feed economizers is given in Figure 6, showing the minimum profitable temperatures of gas leaving the economizer, with various temperatures of entering water, and also the temperatures of water leaving the economizer, corresponding to the various gas temperatures above which the economizer is less efficient than the boiler.



The Engineering Magazine

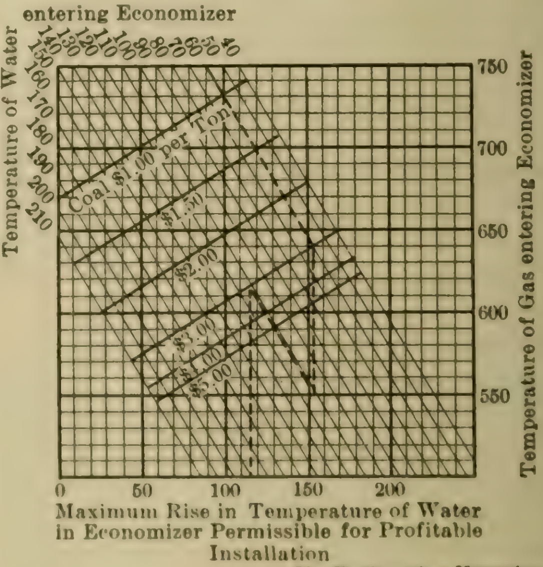
FIG. 5. SHADED AREA GIVES LIMITS OF GAS TEMPERATURE FOR PROFITABLE ECONOMIZER OPERATION WITH WATER AVERAGING 220 DEGREES.



The Engineering Magazine

FIG. 6. LIMITS OF TEMPERATURE FOR PROFITABLE ECONOMIZER INSTALLATION.

"Since the drop in temperature of gas is always equal to about twice the rise in temperature of feed, it follows that, for any combination of temperatures of entering water and gas, with coal at a certain price, there is a maximum permissible rise in feed water. Any attempt to go beyond the maximum will result in either having the final gas temperature so low that part of the economizer is a bad investment or else having the final water temperature so high that a boiler would absorb more heat than the economizer. These maximum permissible rises in feed temperature are shown in Figure 7." The maximum permissible rise is found from the diagram by projecting a line downward from the point of intersection of the lines representing coal cost and temperature of entering water, and the entering gas temperature to give this rise by horizontal projection from the same point. The dotted line shows, for instance, that for coal at $3 per ton and water entering the economizer at 60 degrees, the maximum permissible rise is 153 degrees, and that in order to make the economizer most effective the boilers should be designed to give a flue temperature of 640 degrees.



The Engineering Magazine

FIG. 7. TEMPERATURE RISES IN ECONOMIZERS.

It shows also how the chart may be used to indicate the maximum permissible rise when the gas temperature is not that theoretical most desirable. In the diagram the gas temperature is taken at 550 degrees. A line is projected downward from the intersection of the coal cost and water temperature lines to intersect the 550-degree horizontal line, and from the point of intersection a line is drawn parallel to the water temperature lines to reach the $3 coal line. Immediately below the point so established is read 115 degrees, the approximate maximum permissible rise in water temperature under the conditions.

THE ELECTRIC FURNACE FOR STEEL CASTINGS.

A CONSIDERATION OF THE TYPES OF ELECTRIC FURNACES SUITED TO THE PRODUCTION OF STEEL CASTINGS AND OF THE COST OF THE PROCESS.

G. Hooghwinkel—Sheffield Society of Engineers and Metallurgists.

LAST August we printed in these columns a comprehensive table showing the comparative costs of producing steel in foundries by the open-hearth, Bessemer, crucible and electrical processes. The purpose of the compiler of the data, Dr. Bradley Stoughton, was to indicate the future relation of electric steel-making processes to present methods of foundry work. His estimate of the possibilities of the electrical process Dr. Stoughton expressed as follows: "It is evident that the electric process can hardly hope to compete with any of the prevailing processes except the crucible process, and then usually only when electric power is available at 3 cents per kilowatt hour or less. It may well be, however, that recent developments in the electric process will bring its cost down to the point where the converter process will be superseded to some extent, especially in view of the very high quality of electric steel."

A more optimistic prediction of the future of the electric furnace in the production of steel castings is made by G. Hooghwinkel in a recent paper before the Sheffield Society of Engineers and Metallurgists, abstracted in *The Electrician* for June 3. "The electric furnace," he says, "will be found a necessity in all large steel works for the production of high-class uniform steel for different purposes in large quantities and to various specifications at reasonable prices. The chemical, physical and machining qualities of steel castings produced electrically are far superior to those produced in crucibles on account of the facility and safety with which any specified quality can be produced."

Mr. Hooghwinkel assails the belief of many manufacturers that the electric furnace is destined to be used only where very cheap electric power is available. The cost of power is only a small fraction of the total cost of the electrical process, about 3 per cent. for hot charges and about 8 per cent. for cold. Even with a town supply at a price between ½d. and 1d. per unit, the production of electric steel is a commercial proposition of no uncertain merit. Where a cheap supply of electric power is available from the utilization of waste furnace gases, the power can be used more economically and profitably in large-scale electric-furnace operation than in supplying the other demands of the steel works. Electric furnaces supply an excellent central-station load on account of their high power factor (50 per cent. for hot charges and 75 per cent. for cold), and where furnace operations can be arranged so as not to coincide with peak loads, as is done at Niagara Falls and other places in the United States, supply companies find it advantageous to supply current at very low rates.

The superiority of the electrical over the crucible process lies in the disuse of the expensive and short-lived crucible, which has the inherent disadvantage of introducing impurities into the steel. In addition, the high temperature of the cast is of advantage in manufacturing complicated parts. Castings such as have been made for a considerable time in Girod, Stassano, Héroult, Kjellin and other furnaces are distinguished by a very high elongation value (25 per cent. with a breaking strength of 60,000 pounds per square inch) and low percentages of sulphur (0.03 per cent.) and of phosphorus (0.06 per cent.), properties particularly valuable in railway and motor car materials, etc. The pure Swedish iron formerly used in the crucible furnace for this class of work cost £10 per ton, and the casting about £15 to £20 per ton. As shown in the accompanying cost data, the cheaper materials used and the lower cost of operation of the electric furnace have reduced the cost of production of steel castings in a 1-ton Stassano furnace to £9 per ton. The cost of labor is materially affected by the simplicity of handling of the simple pouring furnace, which entails much less attendance than the heavy and cumbersome crucibles. Furnaces for this class of work should be of from one to three tons capacity. The cost of such a furnace complete varies from £750 to £1,500, according to the type chosen. A 1-ton Stassano furnace will require an average of 200 kilowatts during the four hours the power is required, using about 800 units per ton of steel produced. The lists of installations published in these columns in our January, 1909, and May, 1910, numbers show that at least 60 electric furnaces are now engaged in the production of steel castings. "One or more electric furnaces," says Mr. Hooghwinkel, "should be installed in every iron and steel works with a pretence of up-to-dateness, and not only this, but in such works as naval and shipyards, locomotive and carriage works, bridge-building works, machine shops, electrical works, etc., small electric furnaces producing steel for castings should be indispensable. The very materials used, scrap, trimmings, stampings, punchings, steel and iron borings, etc., which are always used at such works, point to the utility of such furnaces not only as refuse destructors, but as the means of producing their own castings at a very low price, thereby making them independent of the foundries, and giving them facilities for regulating deliveries to meet with modern demands for promptness.

"The electric furnace will also replace the small converter which is now often used with or instead of the open-hearth, in shipyards, for example. Such a converter as a rule produces a quantity in excess of the requirements, so as to prevent the converter from cooling off. The electric furnace is a combination of the cupola furnace and the small converter, and produces a superior material (less sulphur and phosphorus) from an inferior charge (60s. instead of 90s. for special pig) in smaller quantities, at a lower cost. A further product to be made in the small electric furnace is malleable cast iron, which is now made in the cupola furnace, the crucible, the small converter and the reverberatory furnaces at higher cost, at least for small quantities, on account of the high fuel charges and expensive special pig iron used."

In choosing a furnace it must be remembered that the initial charge to be used will be cold. A resistance furnace, or, better still, a combination furnace, will fulfil the requirements; the Héroult, Stassano, Girod and Rodenhauser furnaces have given excellent results in the production of steel castings. When fairly pure materials are used and no refining but smelting and "killing" is required, a plain induction furnace such as the Kjellin will give an ideal crucible steel; furnaces of this type rarely exceed a capacity of two tons. Inherent electrical disadvantages and the difficulty of obtaining a hot and fairly liquid slag prohibit the use of induction furnaces when the materials are so impure that refining is required. A type of furnace which combines the advantages of the pure resistance furnace (ease of handling and regulation) with those of the arc furnace (adaptability to current supply and charge materials) is the Grönwall furnace, which uses two-phase current in two vertical electrodes, the common return being through the bottom lining. The furnace is simple in construction and requires no rotary movement on account of the vertical and horizontal effect of the two phases. Maintenance charges for lining, a rammed mixture of dolomite or magnesite and tar, are small.

COST OF STEEL PRODUCTION AND FURNACE REPAIRS IN ACTUAL PRACTICE.

GIROD FURNACE AT UGINE, 2 TONS.

Charge: Cold scrap, turnings and some cast iron and iron ore. Total time required: Rated at 275 kilowatts, 5 hours per ton of steel.

	Per Ton.		
Lining repairs: (dolomite or magnesite paste)	£0	6	0
Electrodes consumption: (40 pounds, ordinary retort carbon)	0	4	0
Energy consumption: (850 kilowatt-hours plus 10 per cent. loss, say 900 units at ½d. per unit)	2	0	0
Wages (2 men)	0	4	9
Materials charged, say, 1 ton scrap	3	0	0
224 pounds lime, 224 pounds iron ore, ferro alloys, hammer scale	0	3	6
Upkeep of furnace, wear and tear of plant, ladles, etc.	0	12	0
Depreciation	0	1	6
	£6	11	9

Cost of furnace plant complete without power plant, £1,000. In case molten steel from a Bessemer converter, Martin or open hearth furnace is charged into the furnaces, the energy consumption and cost is reduced to one-third of the values given.

STASSANO FURNACE AT THE BONN FILE WORKS.

Replacing 32 crucible furnaces of 6 crucibles, each of 75 pounds capacity. Rating: 185 kilowatts. Charge: cold. Soft scrap, etc. Smelting period: 3½ hours. Refining period: 1 hour. Total time: 4½ hours. Daily production of cast steel, 3 tons.

Energy consumption per ton of steel, 909 units at ½d.	1	18	0
Electrodes consumption	0	2	6
Repairs to lining (£20 per lining, 33 charges)	0	11	0
Wages (3 men)	0	8	8
Cooling water (440 gallons per ton)	0	0	5
Upkeep of furnace, wear and tear of plant	0	10	0
Materials: 1 ton scrap	3	7	0
44 pounds hammer scale, at 17s. per ton	0	0	4
44 pounds lime, at 12s. per ton	0	0	3
17½ pounds ferro-silicon (12 per cent.), at 150s.	0	1	2
9 pounds ferro-manganese (80 per cent.), at 220s.	0	0	11
1½ pounds aluminium	0	1	2
Depreciation, 10 per cent.	0	4	2
Duration, 5 hours. Total	£7	5	7

This means per ton of finished castings 1.5 tons of molten steel, less 0.5 ton of scrap, say, 180s., £9. Cost of furnace complete, £1,500. The lining lasted an average of 70 charges.

KJELLIN FURNACE AT GYSINGE.

1½ tons charge of cold pig iron, very pure iron ore, briquetted. Rating, 175 kilowatts. Single-phase, 15 periods, 500 volts, power factor, 0.7. Produced crucible quality steel.

Cost per ton of steel (melting only):—

Energy consumption, 800 units, at ⅛d. (water power)	£0	7	10
Repairs to lining	0	3	5
General expenses	0	5	7
Wages	0	7	3
Cost of casting	0	4	6
Materials: 1 ton of scrap at 80s.	4	0	0
Flux	0	2	1
	£5	10	8

The low figure is, of course, due to the low charges for power. Interest and depreciation are also not included.

RODENHAUSER FURNACE AT VOLKLINGEN, 2 TONS CAPACITY.

Rating: three phase, 350 kilowatts, 500 volts, 50 periods, 0.8 power factor. Refining only: Charge, hot from basic Bessemer converters containing 0.08 per cent. phosphorus and 0.1 per cent. sulphur. Product: Crucible steel for castings.

Energy consumption, 300 units at 1.09d.	£1	7	0
Heating up	0	1	2
Repairs to lining (10 days, or 160 tons per lining)	0	1	6
Other repairs	0	0	10
Wages	0	2	0
Materials: 1 ton liquid steel	3	9	0
Mill scale, lime, ferro-silicon	0	4	5
Interest and depreciation (15 per cent.)	0	1	5
	£5	7	4

Cost of complete furnace, £2,700. The cost of power per unit in this case was, of course, very high.

The hottest part of the charge is the slag, so that refining can be carried on until the desired result is obtained.

No type of furnace unites all the conditions which must be satisfied by a furnace for the production of steel castings in the same degree. Local conditions and requirements must govern the choice. It is possible, however, to indicate the requirements of a satisfactory furnace and the furnaces which are particularly adapted to fill them. These are:

(*a*) Good thermal efficiency and high power factor combined with medium output (Héroult, Girod, Grönwall and Rodenhauser);

(b) Easy and simple handling, regulation and repairs (Grönwall, Kjellin and Rodenhauser).

(c) Adaptability to all kinds of initial materials, charged either hot or cold (Héroult, Girod, Stassano, Grönwall and Rodenhauser);

(d) Ability to work with an ordinary three-phase supply, and a fairly constant energy consumption (Stassano, Grönwall and Röchling-Rodenhauser);

(e) Ability to use low voltage at the furnace (Girod, Stassano, Grönwall and Héroult);

(f) Ease of refining with a basic slag, even with impure materials high in sulphur and phosphorus (Girod, Röchling-Rodenhauser and Héroult);

(g) Production of a homogeneous bath of molten metal, even after the refining process has been completed (Rodenhauser, Kjellin, Frick and Grönwall).

"It may be stated generally that all the furnaces being vertical electrodes through the roof of the furnace offer the disadvantage of heavier repairs to the roof lining, due to the unequal heating, and that all furnaces using electrodes have the disadvantage of heavy energy losses (over 10 per cent.) in the electrodes. One of the future modifications will certainly be in the direction of the use of metallic electrodes inclined at an angle of 45 degrees."

THE DESIGN OF FURNACE ELECTRODES.

SIMPLE RULES FOR PROPORTIONING ELECTRIC-FURNACE ELECTRODES ACCORDING TO HERING'S LAW.

Carl Hering—Electrical World.

ONE of the first results of an investigation of the design of electric-furnace electrodes, begun more than a year ago by Carl Hering, was the demonstration mathematically of the law of energy loss which now bears Mr. Hering's name. Briefly stated, Hering's law is this: that the total waste of energy in the electric furnace is a minimum when the thermal conduction losses, due to the conduction of heat from the furnace through the electrodes, and the joulean losses, due to the expenditure of electrical energy in heating the electrodes by the passage of the working current, are equal and cancel each other. This remarkable conclusion aroused a great deal of criticism, much of it adverse, and certain theoretical objections to the general application of the law have proved to have been well taken. By practical experiment, however, Mr. Hering has demonstrated conclusively that under the conditions of practice the law is sound. He has reduced the design of furnace electrodes to a few very simple rules, which, together with a table of specific physical constants determined by Mr. Hering, are given briefly in the pages following, after an article contributed to *Electrical World* for June 16.

"The complication in the design of an electrode lies in the fact that, being necessarily a good electric conductor, it was naturally also a good or fairly good heat conductor and therefore carried off heat from the furnace, whereby it chilled the furnace products around the hot ends of the electrodes; this not only wasted a lot of heat, but reduced the capacity of the furnace, and in some cases very greatly, by reducing the temperature of those parts located around the electrodes.

"The total loss is made up of two parts: one, that due to the resistance, and the other, that due to this loss of conducted heat, and the question is: what proportions will make this total loss the least? It is evident, without any mathematics, that if the current in a given electrode is increased (or the cross section for a given current diminished) the electrode will become hotter and hotter due to its electrical resistance. By thus increasing the resistance heat, a point will evidently be reached when the hot end will be heated by the current to the same temperature as that of the furnace, TABLE OF ELECTRODE CONSTANTS.

Temperature Drop. C.	Fahr.	Section s. Square Inch.	Square Centimetre.	e. Volts.	Current i. Inch Units.	Centimetre Units.
Copper						
800	1,472	.000014	.000036	0.18	70,300	27,700
1,000	1,832	.000014	.000035	0.22	71,800	28,300
1,200	2,192	.000014	.000035	0.26	72,800	28,700
1,400	2,552	.000014	.000035	0.30	73,400	28,900
1,600	2,912	.000013	.000034	0.34	73,900	29,100
1,800	3,272	.000013	.000034	0.38	74,300	29,300
2,000	3,632	.000013	.000034	0.42	74,600	29,400
Iron						
800	1,472	.000100	.00026	0.29	10,000	3,900
1,000	1,832	.000100	.00025	0.30	10,000	3,900
1,200	2,192	.000099	.00025	0.43	10,100	4,000
1,400	2,552	.000099	.00025	0.49	10,100	4,000
1,600	2,912	.000098	.00025	0.56	10,200	4,000
1,800	3,272	.000098	.00025	0.63	10,200	4,010
2,000	3,632	.000098	.00025	0.70	10,200	4,010
Graphite						
1,000	1,832	.00025	.00063	1.3	4,100	1,600
1,200	2,192	.00023	.00059	1.4	4,300	1,690
1,400	2,552	.00022	.00057	1.5	4,500	1,760
1,600	2,912	.00022	.00055	1.5	4,600	1,810
1,800	3,272	.00021	.00054	1.5	4,700	1,860
2,000	3,632	.00021	.00053	1.5	4,800	1,890
2,500	4,532	.00020	.00051	1.5	5,000	1,960
3,000	5,432	.00020	.00050	1.5	5,100	2,010
Carbon						
1,000	1,832	.00074	.00187	1.9	1,360	530
1,200	2,192	.00064	.00162	2.1	1,570	620
1,400	2,552	.00057	.00145	2.3	1,750	690
1,600	2,912	.00052	.00132	2.5	1,920	750
1,800	3,272	.00048	.00123	2.7	2,070	810
2,000	3,632	.00045	.00115	2.9	2,200	870
2,500	4,532	.00040	.00102	3.3	2,500	980
3,000	5,432	.00037	.00093	3.7	2,700	1,080

and under those circumstances it follows that no furnace heat will leave through the electrodes, because no heat will flow between two points which have the same temperature. Hence, under those conditions the furnace will have its full capacity because there will be no chilling around the electrodes, and there will be no loss of furnace heat through the electrodes, which then act as a perfect heat insulator. The fundamental principle of furnace design is, therefore, *so to proportion the cross section and length that the current will heat the hot end to the furnace temperature.*" The methods of design described below, and the table of physical constants appended, are based on this principle.

"The rule for determining the best cross-section is as follows: The current and the drop of temperature between the inside of the furnace and the outside ends of the electrodes are supposed to be given by the specifications of the furnace. The length of the electrode can be made anything one chooses, but some definite length must be fixed before the cross-section can be determined, as the cross-section depends on the length.

"For this drop of temperature, find the corresponding value of s in the accompanying table for the material which is to be used. This number is the specific section for that drop of temperature; it is quite analogous to specific resistance, that is, to ohms per cubic inch or per mil-foot, etc., at a high temperature; it represents the section per ampere and per inch (or centimetre) length. Hence, the proper cross-section (in square inches or square centimetres) is equal to this specific section s multiplied by the current in amperes and the length (in inches or centimetres, as the case may be). By repeating this very simple calculation for each of the several materials and for various lengths, if there should be any choice in them, the results will show what it is best to use and will enable the cost of the electrodes to be readily determined. The size thus obtained is the one which will not chill the furnace product by the abstraction of heat, and which corresponds approximately to the section giving the condition of least total loss of energy in the electrodes.

"It is also often of interest to know what the total loss of energy in the electrode is. This is also an extremely simple calculation when the electrode is proportioned as above described. From the accompanying table find the value of e for the given material and temperature drop, and multiply it by the current; the result is the total loss in watts for one of the electrodes. This value of e is again a specific quantity, being the total loss (in watts) per ampere for each electrode. It applies correctly only to electrodes proportioned as above described.

"Sometimes it is also of interest to find out how much current could be used in an existing furnace with given electrodes, because in any case, no matter how badly the electrodes have been proportioned, it is always possible to so change the current (generally by increasing it) that the existing proportions are correct; and as electrodes proportioned according to the older rules are often far too large, the capacity of such a furnace can, by increasing the current, generally be greatly increased besides diminishing the relative loss. To determine this correct current, find the proper value of i in the accompanying table, multiply it by the existing section in square inches and divide it by the length in inches (or use centimetres and the corresponding value of i); the result is the current in amperes which corresponds to those proportions of the electrodes. This value of i is again a specific quantity, being the proper current per square inch section, for an inch length."

In all these calculations the length is only that part of the electrode embedded in the walls, which is necessary to carry the current from the outside to the inside. The portions which project beyond the walls either inside or outside have entirely different functions and their proportions are based on entirely different considerations. The essential part may, however, without any great error include a portion of that embraced by the water-jacketed terminal and a portion of that which may project into the inside. Any portion of the electrode outside the furnace is, of course, a dead resistance, and the loss in it cannot be utilized to check the outflow of furnace heat, as is the case with the resistance loss of that part embedded in the walls; hence, exterior portions should be made as short as practicable, and wherever possible the terminal should be placed quite close to the furnace wall and the electrode fed through it.

With respect to economy of both materials and power, the materials available for furnace electrodes rank in the following order: copper, iron, graphite and carbon. The smaller and more efficient metal electrodes should be used wherever practicable. "The proper cross sections for all materials and for the same length and current become smaller the higher the temperatures, and as this decrease seems to becomes less and less, it follows that at high temperatures the cross section becomes less and less dependent on the temperatures, which means that for the arc furnaces, in which the temperatures are higher, it is not necessary to know these temperatures accurately in order to calculate the sections, as they will be nearly the same for all the higher temperatures. For iron the section is practically the same for all temperatures. This is not true, however, of the power loss for the same current, as this seems to increase roughly in proportion to the temperatures, although for graphite it seems to approach toward constancy. For the same electrode, however, if the temperature is increased by increasing the current, the total loss is very nearly proportional to the temperature for all materials. Hence, as far as loss in the electrodes is concerned, the temperature of a furnace should not be any higher than what is required for the desired thermal reactions."

MARINE APPLICATIONS OF ELECTRICITY.

A SYMPOSIUM DEALING WITH THE APPLICATIONS OF ELECTRIC POWER IN MARINE WORK.

The Electrician.

A SPECIAL issue of *The Electrician* for June 10 contains a symposium of fifteen papers dealing with various applications of electrical engineering in marine work. It is not our purpose here to give an extended abstract of any of these papers. They all possess an interest and authority which would render a selection difficult. We present below, however, a brief summary indicative of the scope of the discussion, which will incidentally demonstrate the growing importance of electrical engineering as applied to marine work.

An editorial review of the evolution of electrical engineering in the British Navy traces progress in the employment of electrical apparatus on war vessels from the earliest application to the present time. The diverse conditions of ship and shore applications of electricity are emphasized. The general lay-out of the electrical equipment and the way in which it is maintained are then described, and the paper concludes with a consideration of the methods employed in ship lighting and a summary of the directions in which the electric motor is employed on board a modern battleship.

The application of electric motors to marine propulsion, as might be expected, receives a good deal of attention. No fewer than four systems are described. Henry A. Mavor investigates a special case of marine propulsion where the existing method of driving is admittedly efficient and cheap; he shows that while the possibilities of economy are restricted, there is still a strong case for electrical methods. The logs of two voyages are used to illustrate the argument that the "load factor" is likely to be an important element in the consideration of economical working at sea as it is on land. William P. Durtnall presents the claims of his well known "Paragon" system. After a brief reference to the conditions to be observed in marine propulsion, Mr. Durtnall considers in detail the effect of substituting for steam drive the Paragon electric system in two special cases. In the first case, that of the *Lusitania,* the saving in weight of machinery is shown to be immaterial; the saving in coal and wages, however, is considerable. The second case discussed is that of a 500 horse-power tramp steamer now in process of conversion to electric propulsion on the Paragon system. The new Bailey system of turbo-electric propulsion is described by H. C. Leake. Ordinary three-phase generators and squirrel-cage motors are used, and speed variation of the propelling motors is obtained by varying the speed of the turbo-generators. To enable the motors to be reversed, braking drums, mounted on the turbine shafts, are employed, which may be described as a species of turbine designed to absorb power instead of to produce it. Lieut. W. P. Sillince discusses the application of the Diesel engine to marine propulsion. Following a general outline of the construction, economy, etc., of the Diesel engine and its present employment in boats, Lieut. Sillince describes the Mirrlees system of electro-mechanical propulsion. Generators direct coupled to Mirrlees-Diesel engines are used. For speeds between full speed and half speed a combination friction and positive clutch couples together the engine and propeller shafts. For speeds below half speed the shafts are disconnected and motors are used.

Turning now to the employment of electricity for purposes other than propulsion, A. G. Collis summarizes former and present specifications for switchboards for warships, and criticizes the lack of uniformity in design. It is essential that manufacturers entering this field of work should specialize. It is also highly desirable, he urges, that parts of gear should be interchangeable even if made by different makers. The wiring of ships is treated by G. Austin. After enumerating the uses to which electricity is put on board ship and the various circuits that are desirable, Mr. Austin discusses the question of the most suitable voltage, and the various systems of wiring that may be used—single wiring, concentric and double wiring. The wires may be protected by wood casing, tubes, lead sheathing or armoring. Twin cable has much to recommend it. The insulation of wiring is rendered difficult by condensation and by the inevitable presence of salt. Careful erection is most important. Distribution may be on the system in which each light has its own fuse, or on that in which each group has a fuse; the latter appears to be sufficient. Owing to the special conditions, bell wires, as well as those for supply, should have good insulation. Mr. Austin contributes also a paper on ship illumination and fittings, in which he discusses the character of lighting and fittings suitable for decks, cargo holds, cattle spaces, emigrant accommodation, seamen's and officers' quarters, passengers' cabins, dining saloons, lounges, drawing rooms and smoking rooms, signal lamps and navigation lamp indicator. He shows the necessity of paying particular attention to insulation and the prevention of trouble by vibration. Illumination is further considered in a paper on searchlight projectors for marine purposes by E. A. Holmes, who describes various types of mirrors, methods of testing, systems of arc production, and accessory devices.

Two papers are devoted to electrical communication. The first, on ships' telephones, by H. S. Thompson, describes the general scheme adopted on board a ship, which, from the telephone point of view, may be looked upon as a large hotel. The instruments and other details, such as wiring and protection from stray currents, are considered. Owing to the special conditions at sea, such installations differ materially from those on land. For connecting a ship to a shore exchange, a special flexible cable, with connecting boxes is used. Wireless telegraphy for marine inter-communication is discussed by W. W. Bradfield. He outlines the advantages and progress of wireless telegraphy for marine purposes, and describes in detail the transmitting, receiving and emergency apparatus of the Marconi plant used on board ship. In conclusion, particulars are given of the number of naval and mercantile marine stations in operation in the various countries.

A paper is included on electrically driven shipyard cranes. The author, H. H. Broughton, first considers briefly certain details which affect the performance of all types of electric cranes. In the second part of his article descriptions are given of several cranes and crane systems in use in a number of the principal shipyards; these include yard cranes, building-slip equipment and fitting-out basin cranes.

One of the most interesting of the articles is James A. Seager's general discussion of the use of electric power for auxiliary purposes on board ship. The chief causes which militate against its adoption, he says, are the lack, in most cases, of definite specifications for the plant required, the ignorance of marine engineers of electrical matters, the lack of skilled attention, the desirability of simplicity of equipment, and the cutting of prices. The voltage used is preferably low for safety, but the use of electric power tends to raise the standard adopted. Although there is a tendency to run all auxiliaries electrically, it is safer to have some of them independent of the electrical plant. To a large extent the adoption of electrical auxiliaries resolves itself into a question of first cost *versus* running cost. Mr. Seager concludes his article with a reference to examples of auxiliaries now in use, and emphasis is laid upon the necessity for good workmanship and ample size of plant for the requirements.

Electric steering gear is the only auxiliary to which a special paper is devoted. A. P. Chalkley describes a number of systems of electrical steering, in particular those of the A. E. G., Pfatischer, Siemens Brothers, Clarke, Chapman & Co., and Brown Brothers. Mr. Chalkley contributes also an estimate of the future of electricity on ships. He points out that two tendencies are now apparent—either to use electricity for all purposes, or to apply it to every purpose except that of propulsion. For generating purposes it is important to bear in mind the possibilities of the Diesel engine. Producer plant has also been suggested, but the future in this line seems doubtful. On the other hand, the position of the turbine is assured. The standard voltage shows a tendency to rise, and there is much to be said in favor of alternating current in preference to continuous. A marked advance may be expected in electrical steering gear. Generally speaking, Mr. Chalkley concludes, it may be said that the outlook for electricity on ships is very promising.

THE CUTTING PROPERTIES OF TOOL STEEL.

AN INVESTIGATION OF THE FACTORS INFLUENCING THE DURABILITY OF CUTTING TOOLS.

Edward G. Herbert—Iron and Steel Institute.

COMMENTING editorially on a paper on the cutting properties of tool steel, read by Edward G. Herbert at the recent meeting of the Iron and Steel Institute, *The Engineer,* London, says that no more remarkable contribution to the literature of the subject has been made since the publication of Taylor's voluminous monograph, "The Art of Cutting Metals." Mr. Herbert's experiments were made on a novel form of testing machine, invented by himself, which we have already described in these columns.* It will be recalled that in this machine a steel tube, ¾ inch in diameter and 1/16 inch thick, rendered of a uniform hardness throughout by suitable heat treatment, is revolved in a vertical position at a suitable speed, and is thrust against a cutting tool by a predetermined weight. The tool is carried in a steelyard and a micrometer shows the amount by which it wears away as it cuts the face of the tube. An autographic apparatus records the rate at which the tube is shortened by the tool, and an electric alarm gives warning when a standard degree of bluntness has been reached. The machine offers facilities whereby all the conditions of a cutting test can be regulated and kept constant, and it is possible, therefore, to obtain with it truly comparable results.

We gave in our previous review of Mr. Herbert's work some of the results of his earlier investigations. His purpose throughout has been thoroughly practical—to discover the conditions of metal cutting determining the best workshop results. "The best steel," he says, "is not the one which will keep its edge longest when run at a low speed, nor even the one which will remove the greatest amount of metal without becoming blunt. The engineer usually requires the steel that will remove the greatest amount of metal per hour without requiring too frequent sharpening." One of the most striking of Mr. Herbert's discoveries was the fact that the durability of all steels without exception is very low at low speeds (under light cuts), and that the durability of the cutting edge increases as the speed is raised. The research reported in his present paper is an investigation of the cause of the difference in the durability of the cutting edge of a given steel at different speeds, and of the changes in the physical condition of the steel which correspond to these changes in durability. The results appear fully to justify the conclusion indicated at the close of our previous review—that the durability of a cutting tool is almost entirely dependent on the rate at which heat is generated in cutting.

Mr. Herbert's argument is as follows: A decrease in durability with increased cutting speed might be very simply explained by saying that we are dealing merely with the rubbing of metal against metal, and that the increased wear at the higher speeds is due to the increased severity of the rubbing. But when we find that an increase in the cutting speed is actually accompanied by an increase in the durability of the tool, that this durability attains a maximum at a certain speed, which is different for steels of different chemical composition, and that the durability then declines as the speed is further increased, it becomes evident that the durability of the cutting edge cannot depend simply on the rubbing of metal against metal. It may, however, depend on that which results from the rubbing, namely, the evolution of heat and the consequent rise in the temperature of the cutting edge, a rise which naturally becomes greater as the speed increases. Assuming this to be the case, we find that the durability or wear-resisting property of all tool steels is relatively low at normal atmospheric temperatures, that it increases as the temperature rises, attains a maximum at a certain temperature (depending on the composition of the steel), and declines as the temperature is further raised.

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* THE ENGINEERING MAGAZINE, August, 1909.

This theory Mr. Herbert has tested both by varying the temperature of the cutting edge by increasing the depth of cut taken at a constant speed, and by varying the temperature by the application of artificial heat to the tool, by causing hot water to circulate through the test tube of the testing machine, in place of the cold water normally used in durability tests. The results given in the paper appear to establish the heat theory of the durability of cutting tools working under the special conditions of the tool-steel testing machine. Its validity under workshop conditions is tested by means of Taylor's results. Mr. Herbert deduces from theoretical considerations a law of constant temperature in terms of feed, speed and depth of cut, which may be expressed by the equation

$$S_2 = S_1 \sqrt[3]{\frac{t_1\, a_1}{t_2\, a_2}}$$

or in words: For constant durability of the cutting tool, the speed varies inversely as the cube root of the product of area of cut and thickness of shaving. According to hypothesis, this law of constant temperature should be also a law of constant durability. That it is so is definitely established by comparison of data obtained by calculation from the cube law with the results of Taylor's shop durability tests.

There is already an accumulation of confirmatory evidence of the validity of the heat theory of durability from the workshop side. It is a matter of common experience, for example, that a tool stands up better if it is put in the fire immediately before being set to work, so that it "starts warm." Further, in quite a number of workshop operations it has been found possible to increase the durability of the cuting tool by increasing the cutting speed, although such an increase of speed goes against the instincts of the average workman.

Most of the speed, or temperature-durability, curves examined by Mr. Herbert have a simple form, rising to a point of maximum durability and then falling towards zero durability as the speed is raised. Some curves, however, a number of which are shown in the paper, have two points of maximum durability and a very distinct depression between them. This phenomenon is exceedingly common and is not confined to any one class of steel; the double-peaked curve has been obtained from carbon, tungsten, and tungsten-vanadium steels. Experience shows that the depression may occur at any point in the curve of any steel, and that its position varies according to the particular treatment the steel has received in hardening. The depression or dimple in the speed curve is perhaps the most remarkable fact brought to light by the tool-steel testing machine. The phenomenon is so marked—amounting sometimes to an almost total loss of durability at a particular speed which may be intermediate between two speeds, each of which gives the tool the highest durability of which it is capable—that it is almost incredible that it should have entirely escaped observation in the thousands of cutting operations of everyday practice. There is a good deal of evidence that the phenomenon exhibited in the speed curve is one which has been frequently observed in practice, though its precise character has never been suspected. Unaccountable failures of cutting tools are among the commonest of workshop experiences, and may be frequently due to working at the critical temperature of low durability. To cite only one example, it is frequently observed that a tool, soon after being set to work, apparently fails—it becomes blunted to some extent; but if it is allowed to continue cutting, it "builds up," it recovers its durability, and may continue cutting for a considerable time without further loss of sharpness.

The second purpose of Mr. Herbert's research, to determine the changes in the physical condition of steel which correspond to the changes in durability, remains to be considered. Many experiments have been made on carbon, tungsten, and tungsten-vanadium steels to ascertain in what manner the durability of a tool is affected by its temper, percentage of carbon, and the cooling process to which it has been subjected. Detailed results are given in the paper. We may quote from Mr. Herbert's summary of the conclusions so far established: "Taking a general review of the results put forward, it is clear that the three classes of steel experimented with are all capable of producing either a single- or a double-peaked curve. The second or high-speed peak is strongly developed in high-speed and carbon steels which have been quickly cooled. The first or low-speed peak is developed in high-speed steel by slow cooling, and in the case of carbon steel by tempering at a high temperature. The effect of tempering high-speed steels has not been determined.

"A moderate rate of cooling, or in carbon steels a moderate tempering, produces a double-peaked curve, the steel having great durability at both low and high speeds, but very little durability at some intermediate speeds. The curve of the tungsten-vanadium steel differs essentially from that of the tungsten steel similarly treated, but whether this is generally characteristic of the two classes of steel, or peculiar to the particular brands used in the experiments, has not yet been determined. Salt-bath hardening seems to be generally beneficial in the case of tools intended for high-temperature cutting.

"No plausible hypothesis can yet be offered in explanation of the peculiar changes in the durability of steels; indeed, we have yet to determine what constitutes durability. It cannot be mere hardness, since there is no increase of hardness at increasing temperatures corresponding to the increasing durability shown by the rise of the left-hand portion of the speed curve. It seems more probable that this first increase of durability is due to a decrease of brittleness—a stronger coherence of the molecules as the temperature is raised. The decrease of durability shown by the descending portion of the curve may be due to an actual softening or tempering of the steel by the heat generated in cutting. The decrease of durability corresponding to the depression in the double-peaked curve can scarcely be due to a tempering process, since the steel could not in that case be expected to regain its durability at higher temperatures. This temporary loss of durability may, however, be due to an increase of brittleness occurring at certain temperatures. If this can be established by means of breaking tests on hot specimens of steel which have been so treated as to give a double-peaked curve on the tool-steel testing machine, it should not be difficult to establish a partial temperature scale corresponding to the testing-machine scale of cutting speeds.

"Nothing has been said about the relation between the speeds used in the tests and the corresponding speeds appropriate to any given set of actual working conditions. This relation cannot be established by direct application of the cube law, since this takes no account of the shape of the cutting tool and the hardness of the material operated upon. In the absence of any means of measuring actual cutting temperatures, the relation can only be established by making a complete speed curve in the lathe under ordinary working conditions, and comparing this with the curve made from the same tool on the testing machine. By preference, the tool chosen should be one which gives a double-peaked curve, since it would in that case be possible to correlate three distinct points on the curves, two maxima and a minimum."

A COMPARISON OF LATHE HEADSTOCK CHARACTERISTICS.

A METHOD OF ANALYSIS OF SPEED-TORQUE RELATIONS FOR THE USE OF DESIGNER AND PURCHASER.

Walter Rautenstrauch—American Society of Mechanical Engineers.

PROGRESS in the development of high-speed steels and the rapid accumulation of authentic experimental data of their properties and capabilities have reacted to a marked degree on machine-tool design. Charles Day has given in this Magazine* a number of examples of radical changes in tool construction designed to promote efficiency by limiting tool duty and by introducing characteristics adapting the machines to the most efficient use of the new steels. At a time when new designs are frequently offered and improvements are constantly added to existing types, it is important that the purchaser of machine tools should have a ready means of determining the suitability of a machine to his peculiar conditions; this Walter Rautenstrauch has supplied in a paper on the scientific analysis of lathe headstock characteristics, read before the American Society of Mechanical Engineers and printed in the *Journal* for June.

Since the new steels will take heavier cuts than is possible with carbon steels and still retain their durability, Prof. Rautenstrauch takes as the basis of his standard of comparison those characteristics of speed and torque in a lathe headstock which permit the most economical removal of shavings from soft and medium steels. The method of comparing the speeds and torques actually obtainable in any machine with the standard characteristics, for the purpose of judging the efficiency of the headstock, is that devised by Dr. J. T. Nicholson. The considerations on which the Nicholson method is based are as follows: "Since the volume of metal removed by a lathe tool in a given time is a product of the area of cut and the speed of cutting, the weight removed in one minute will be equal to the area of cut in square inches times the speed of cutting in inches per minute times the weight of the metal per cubic inch. The force on the tool has been determined experimentally to be approximately proportional to the area of the cut, the torque required to take any size cut is equal to the force on the tool times the radius of the work, and the speed at which the cut can be taken on any diameter of work depends on the spindle speed which can be obtained. These facts, together with the relations which have been established between possible maximum cutting speed and area of cut on different materials, show that in any machine a definite relation must exist between the spindle speeds and the accompanying torques obtainable, that the machine may be adaptable to efficient weight removal on all diameters of any material."

The approximate relation between the area of cut and the maximum cutting speed for soft and medium steel is expressed by Dr. Nicholson in the equation:

$$V = \frac{1}{a} + 15$$

where V is the cutting speed in feet per minute, and a the area of cut in square inches. From this equation may be determined the cutting speed at which it is possible to operate on these materials without injury to the tool, when taking a cut of a given size. To establish a basis for determining the spindle speeds and torques required to remove the maximum weight of shavings on all diameters of work, it is necessary to determine the average area of cut which a lathe of given size should be expected to take. Through correspondence with lathe builders, Dr. Nicholson learned that a widely accepted rule for the machining of mild steel forgings is

$$a = \frac{S^2}{25{,}600}$$

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*The Engineering Magazine, July and August, 1909.

where a is the area of cut in square inches, and S the swing of the lathe in inches.

Assuming that these relations are true, and in addition that the force on the tool varies directly as the area of the cut (for mild steel the force on the tool is approximately 100 tons for each square inch of area cut), an 18-inch lathe capable of removing the maximum weight of shavings in a given time on all diameters of work would have the following characteristics: standard area of cut on all diameters, 0.0126 square inch; force on tool, 2,520 pounds; torque on work of face-plate diameter, 1,890 foot pounds; maximum cutting speed, 94.5 feet per minute; revolutions of spindle required for this speed on work of face-plate diameter, 20 per minute. When the standard area of cut is taken on a smaller diameter the resulting torque will obviously be less. It will be necessary, however, to increase the spindle speed, if the speed giving most efficient use of the tool and constancy of volume of metal removed is to be maintained.

The spindle speed for these conditions will vary inversely as the diameter of the work and the torque directly as the diameter of the work. It is obvious, therefore, that when the problem is to remove the maximum weight of shavings on all diameters of work, the product of speed and torque should be a constant. The highest spindle speed for which a lathe should be designed will depend on the smallest diameter of work which the lathe can economically handle, and the maximum cutting speed desirable on this diameter. Assuming that the least diameter is $S/16$, and that a cutting speed of 120 feet per minute should be provided, the maximum spindle speed should be approximately $7{,}200/S$.

From these data a curve may be plotted showing the ideal characteristics towards which the design of a lathe should tend. The abscissae represent torques, and the ordinates revolutions of the spindle. The points representing the combinations of torque and spindle speed for work of face-plate diameter, and for work of the smallest size which can be handled economically are first plotted. An equilateral hyperbola between these points (since the product of speed and torque should be a constant) shows the proper relations of torque and spindle speed required to remove the maximum weight of shavings in a given time on all diameters of work of any given material.

This ideal diagram can be used either in design or as a means of determining the extent to which the speeds and torques of a lathe already designed correspond to the standard established. By its use it is possible also to determine whether or not any speeds, with their corresponding torques, might be omitted without affecting the weight-removing capacity of the headstock. Prof. Rautenstrauch describes in detail the method of using the diagram as a standard of comparison. It is possible here only very briefly to indicate the scope of his discussion. Speed and torque data for thirteen lathes of various swings and by different makers, taken from the manufacturers' catalogues, are plotted in characteristic curves. By reference to the ideal diagram it is shown wherein the designs are deficient, and examples are worked out showing the limits which improper headstock design imposes on either the area or the speed of the cut which can be taken on any diameter of work, and the extent to which the various speeds, with their corresponding torques, contribute to the weight-removing capacity of the lathes. As an illustration of how the relative merits of lathes of different makes may be determined with reference to a common standard, the diagram is used to demonstrate the uselessness of certain speeds, with their corresponding torques, possible in a number of the lathes selected. This analysis shows the striking difference of opinion existing among lathe builders as to what constitutes a sufficient powering of the lathe to meet the demands of the high-speed steels, the number of speeds to be furnished, and the spacing of the speeds and torques.

An analysis of this sort shows two things: first, that increasing the number of speeds without regard to the torque does not necessarily increase adaptability to economic performance; and second, that the amount by which the efficiency can be increased does not increase in direct proportion to the additional number of speed changes provided, even if the accompanying torques are properly determined. The question of increasing efficiency by the introduction of additional speed-torque changes involves a solution of the problem whether or not the increase in efficiency warrants the increase in cost due to the additional equipment, and whether the management of the shop is such as to insure proper use of the additional equipment. Another use for this method of analysis particularly applying to design is the estimation of the beneficial effects of motor equipment on the efficiency of the machine. It affords a simple means of determining the changes which can be effected by applying direct motor drive, when the motor has certain characteristics of speeds and torques, to any particular machine with certain possible speed-torque combinations. The method is one, Prof. Rautenstrauch believes, which will materially assist the designer in determining justifiable speed-torque relations, and will enable the purchaser to determine whether or not the speed-torque characteristics of any given lathe are adaptable to his conditions.

THE ECONOMY OF THE EXHAUST STEAM TURBINE.

A COMPARISON OF THE FIRST AND OPERATING COSTS OF GAS ENGINE AND COMBINED STEAM ENGINE AND TURBINE PLANTS.

W. Heym—Die Turbine.

THE superior economy of the combination steam plant, utilizing the exhaust steam from reciprocating engines in low-pressure turbines, in comparison with plants equipped exclusively with either engines or turbines, is conclusively demonstrated by R. J. S. Pigott in his short series of articles on the revival of the reciprocating engine, concluded on another page of this issue. It is a remarkable fact that the belief is rapidly gaining ground that the combination steam plant is more economical than even the gas-engine plant. At full or nearly full load, and also at low power factor, the gas engine is a strong competitor of the steam engine or turbine. The first cost of the gas plant, particularly when operating on bituminous coal, is high, but the low fuel consumption and operating expense in most cases render the gas-power plant a more economical installation than either steam turbine or engine equipment. This superiority, however, does not persist to the same degree when the gas plant is compared with the combination steam plant. In fact, Herr W. Heym, who compares the first and operating costs of gas and combination steam plants in *Die Turbine* for March 5, finds the combination steam engine and turbine plant more economical within wide limits than the gas-engine installation.

Herr Heym takes the case of a 1,000-kilowatt plant of each type operating under similar conditions. Good steam coal is to be obtainable at from $1 to $3.50 per ton, an adequate supply of condenser water is available, and the cost of labor is to be that in good average practice. Each plant is to be in operation 24 hours per day, with a load factor of at least 20 per cent. At least one-third the total capacity of each plant is to be held in reserve.

A gas plant to meet these conditions will require three tandem, four-cycle, double-acting engine units, with producers and auxiliaries, connected to 500-kilowatt dynamos. For the steam plant it may be assumed that the low-pressure turbine working on exhaust steam is capable of delivering 80 per cent. of the power of the reciprocating engine running non-condensing. The turbine may be of the double-flow reaction type, or possibly, for such a small plant, a single-flow turbine with dummy piston. The mixed-pressure impulse turbine, with a high-pressure nozzle for using live steam during periods of overload, is also applicable. The turbine may be installed as an independent unit, with its own governor, or it may be governed from the engine. At times of low load the turbine can be stopped altogether, and the engine made to exhaust directly into the condenser. A reserve Corliss engine is an advantage in case of accident to either engine or turbine.

The maximum capacity of the boiler plant must be such that in case of accident to the turbine, the two reciprocating engines can operate non-condensing. Assuming a maximum steam consumption of 30.8 pounds per kilowatt-hour under these conditions, the 1,000-kilowatt plant will require a boiler capacity of about 9,000 boiler horse power. These, however, are not the conditions of highest efficiency, and a boiler equipment of four 225 horse-power units (one reserve) will be sufficient for the plant. The boilers will be of the horizontal water-tube type and they will be equipped with economizers, mechanical stokers, internal superheaters, and all auxiliaries. Steam separators will be installed between engine and turbine and the equipment will be completed by a centrifugal jet condenser and a centrifugal dry-air vacuum pump.

Two Corliss compound engines, three three-phase dynamos with exciters and switch gear, and the boiler plant and accessories will cost about $87,500, or $87.50 per kilowatt. The turbo-generator with condenser and auxiliaries will cost about $22,500, or $50 per kilowatt, making the total first cost of the steam plant $110,000. The total cost of the gas plant, including the three engines, generators, exciters, producer plant, and all auxiliaries, will be $142,500, or $95 per kilowatt. The cost of buildings and foundations are not included in these estimates. The comparative first, maintenance and operating costs (exclusive of the cost of fuel) are shown in the following table.

TABLE I. FIRST, MAINTENANCE AND OPERATING COSTS OF 1,000-KILOWATT STEAM AND GAS PLANTS.

	Steam.	Gas.
Two 550-kilowatt steam engines, with dynamos, boilers and all steam and electric auxiliaries	$87,500	....
One 450-kilowatt low-pressure turbine, with dynamo, condenser and all auxiliaries	22,500	....
Three 500-kilowatt gas engines, with producers, dynamos, and all gas and electric auxiliaries	....	$142,500
Total equipment cost	$110,000	$142,500
Interest on capital at 5 per cent	$5,500	$7,125
Maintenance and depreciation at 10 per cent	11,000	14,250
Labor at $7 per day for 365 days of 24 hours	2,555	2,555
Oil, waste, and supplies at $1.75 per day for 365 days of 24 hours	640	640
Total cost of maintenance and operation, exclusive of fuel	**$19,695**	**$24,570**
Total hourly plant cost, exclusive of fuel	**$2.25**	**$2.80**

The labor cost, estimated as the same for both plants, is made up as follows: one day engineer, $2.50; one night engineer, $2; and two stokers, $1.25 each, making the total $7 per day. Oil, waste, and supplies are estimated at $1.75 per day for each plant. Interest is computed at 5 per cent., and repairs and depreciation at 10 per cent., in the case of the steam plant, 11 per cent. for the engines and boilers, and 6 per cent. for the turbine. The load factor has practically no effect on these items of cost. The hourly costs of operation of the steam and gas plants, exclusive of the cost of fuel, are respectively $2.25 and $2.80.

Herr Heym discusses at length the question of fuel consumption, particularly in its relation to load factor. He assumes for the steam plant an evaporation of 4 pounds of water per pound of coal and an expansion from 11 atmospheres to 17.8 pounds pressure in the engine, and to 700 millimetres vacuum in the turbine, with a drop in pressure between engine and turbine of 1.1 pound. For the gas plant it is assumed that the load is very variable and that two engines are in operation the greater part of the time. Herr Heym gives curves showing the comparative fuel consumption per kilowatt-hour in the gas and steam plants at load factors from 20 to 100 per cent.; the fuel consumption of the steam plant is, of course, higher. Another set of curves, however, which combine all elements of operating cost, the price of coal being taken at $3.50 per metric ton of 2,204 pounds, shows that with fuel at this price the steam plant is the more economical at all loads including and above 200 kilowatts, although the difference between the operating costs of the two plants decreases as the load factor increases.

A third series of curves shows the influence of fuel cost on the cost per kilowatt-hour at load factors of 20, 40, 60, 80 and 100 per cent. The greatest difference in cost is apparent at low fuel prices, the cost of power in the gas plant being higher at all load factors. As the price rises, the curves of cost per kilowatt-hour for gas and steam approach each and finally cross. The points of intersection are as follows: at 20 per cent. load factor, $6.75 per metric ton; 40 per cent., $8.50; 60 per cent., $8.75; 80 per cent., $4.25; and 100 per cent., $5. At these prices and load factors, the economy of the two plants is the same. At higher prices the gas plant is the more economical, and at lower prices the steam plant.

Table II. Total Yearly Cost of Operation and Maintenance.

Load Factor, Per Cent.	Steam.	Gas.	Difference.
100	$49,757	$51,009	$1,252
80	44,893	46,750	1,857
60	40,429	43,020	2,591
40	36,750	39,497	2,747
20	33,412	35,504	2,092

Table II gives the total operating cost per year of 8,760 hours for the two plants, exclusive of fixed charges, insurance and taxes on land and buildings, with coal at $3.50 per metric ton. Although the difference in cost per kilowatt-hour is greatest at 20 per cent. load factor, the table shows that the greatest total saving is at 40 per cent. load factor. The introduction of a cooling plant would increase the first cost of the steam plant by $10,750, and the annual operating cost by $1,075 (10 per cent.). Even with unfavorable condensing conditions, however, the steam plant will be more economical at 100 per cent. load factor by about $175 per year.

PROTECTIVE COATINGS FOR STRUCTURAL STEEL.

A REPORT OF EXPOSURE TESTS ON OVER FIVE HUNDRED DIFFERENT PAINTS.

Cloyd M. Chapman—American Society for Testing Materials.

FOR nearly four years past, the firm of Westinghouse, Church, Kerr & Co. has had in hand an investigation of the rust-preventing properties of protective coatings for structural steel. In all, over 1,600 tests have been made, on 530 different coatings, submitted by 271 manufacturers and dealers. The method of testing, and the results obtained, are now made public in a paper read by Cloyd M. Chapman at the recent meeting of the American Society for Testing Materials, from which we quote at length.

"The method employed in most of these tests was as follows: Small samples of the ready mixed paints were submitted by the manufacturer or dealer, together with a statement of the principal ingredients entering into their manufacture. Each paint was applied to two mild steel plates of about No. 16 gauge, 2 inches wide and 6 inches long, which had first been well cleaned of oil and foreign matter by rubbing with a cloth saturated with benzine. Each plate had its number plainly stamped in one corner. One plate was given one coat and the other two coats. Care was taken to give a uniform full coat to both sides and all edges of the plates. All painting was done indoors by the same person. About five days were allowed between coats for drying. After the second coat had dried the plates were fastened to boards with galvanized iron tacks and exposed on the roof at an angle of 45 degrees, facing south.

"On the day the plates were exposed scratch marks were made with a sharp instrument across two opposite corners of each plate. These scratch marks cut through the paint film, leaving bright metal exposed, so that rust could and did start immediately along these lines. At regular intervals after exposure each plate was examined and a record made of its condition. The one quality which was being sought, and the prime factor which entered into the rating of the paints, was protection against rust.

"An arbitrary scale of ratings was adopted, based on the amount of rust apparent on the plate. Until some small spot of rust appeared the plate was rated at 100 per cent., except in cases of fading, alligatoring, bad chalking, etc., without any rust apparent, which were rated at 97 per cent. When one small spot of rust the size of a pinhead appeared the plate was rated at 90 per cent. When several such spots or one larger spot of rust appeared the plate was rated at 85 per cent. When the sum of the areas of the rust spots totaled an area of about ¼ inch square the plate was rated at 80 per cent.; when ½ inch square, at 75 per cent. When the combined area of rust spots totaled about 1 square inch the plate was rated at 70 per cent., and so on down the scale until zero rating indicates the plate entirely rusted on the exposed side. Examinations were made and results recorded at the end of two weeks, four weeks, six weeks, twelve weeks and every three months thereafter. . . .

"As noted above, each manufacturer was asked to state the principal ingredients in his paint, and on the basis of these statements each sample was placed in a group depending upon its chief pigment, or, in the absence of pigments, upon its vehicle. In this way the paints were divided into a number of classes as follows:

Carbons.—In this class are grouped the natural and artificial carbons, except graphite.

Graphites.—This class contains both the natural and artificial graphites.

Iron Oxides.—These also include both the natural and artificial pigments, some of which were received in paste or dry form, to which pure linseed oil was added in our laboratory.

Red Leads.—This class includes both the straight red lead and oil mixed in the laboratory shortly before applying, and the ready-mixed red lead paints which contain considerable percentages of other pigments to keep the lead in suspension. These red leads had no other coating over them.

Red Lead Primers.—These consist of tests in which the first coat was a red lead paint, either ready mixed or straight red lead and oil, while the second coat was of some other class. Of course, no one-coat tests could be made in this way. The second coats in this class were of widely different varieties.

White Leads.—This class is rather surprisingly small, and is made up largely of paints mixed from the paste in our own laboratory.

Zinc Oxides.—Few makers put out a zinc oxide paint for structural steel.

Mineral Hydrocarbons without Pigments.—This class is composed of paints made of the various kinds of tars and tarry refuse and the various minerals of an asphaltic nature, gilsonite, elaterite, etc., but without any pigments added to them. They form one of the more numerous groups, and as a rule are much lower priced than the oil paints. They also form the class for which the greatest merit is usually claimed by the makers and agents.

Mineral Hydrocarbons with Pigments.—This class is made up of the same character of materials as the last, but with various pigments added. For instance, a paint made of gas tar and iron oxide would fall in this class rather than in the iron oxide class.

Vegetable Hydrocarbons with and without Pigments.—This class includes distillates and residual pitches of vegetable oils, etc. They are not numerous enough to divide into two groups, hence those with and those without pigments are placed in the one class.

Cements.—Several manufacturers have acted upon the oft published statement of the fact that Portland cement offers a protection to steel against rust, and have put out a paint said to be made up largely of cement. These paints are here grouped in a class by themselves. As they have appeared in the market mostly within the past two years only one of them has had a full two years' exposure.

Chromates.—Another result of recent paint literature has been the appearance of a number of paints said to contain chromates or chromic acid in some form. Some of these have appeared within the past year and no tests of those can be included in this paper.

Vehicles.—This class contains the oils, varnishes and transparent coatings containing little or no pigment, but which are more or less used for the protection of steel.

Miscellaneous.—Into this class are grouped all the coatings which do not fall into one of the above groups or concerning which the maker refused proper information to enable the paint to be classified. Other sub-divisions were made in our laboratory records, but they each contained so few representatives that they were all thrown into this miscellaneous class for purposes of comparison in this paper.

"In the following table is given a summary of the results obtained with each class of paints for one and two year exposures of one and two coat specimens. This table also gives in each case the number of tests which entered into each result:

TABLE OF RESULTS OF EXPOSURE TESTS OF STRUCTURAL STEEL PAINTS.

	One year exposure.				Two years exposure.			
	One coat.		Two coats.		One coat.		Two coats.	
Class.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.	No. of tests.	Average rating. Per cent.
Carbons	65	21	54	70	34	2	36	46
Graphites	67	18	56	66	42	3	43	45
Iron oxides	74	35	71	69	52	10	52	46
Red leads	50	58	39	77	19	16	20	61
Red lead primers	0	..	43	75	0	..	14	56
White leads	23	51	11	82	3	0	3	25
Zinc oxides	5	25	5	69	5	3	5	50
Mineral hydrocarbons without pigments	66	20	73	46	36	0	37	18
Mineral hydrocarbons with pigments	10	16	11	53	7	0	7	20
Vegetable hydrocarbons with and without pigments	13	19	13	57	3	0	3	5
Cements	7	36	7	46	1	0	1	0
Chromates	14	32	24	70	9	0	9	39
Vehicles	22	8	7	11	3	0	3	0
Miscellaneous	94	28	103	67	70	7	85	39

COMBUSTION IN CEMENT BURNING.

A CRITICISM OF THE ROTARY KILN, AND A SUGGESTION OF A TWO-KILN PROCESS GIVING MORE EFFICIENT HEAT UTILIZATION.

Byron E. Eldred—American Institute of Mining Engineers.

AMERICAN practice in cement burning, according to Byron E. Eldred, exhibits a remarkable crudeness in the application of the principles of combustion, and a no less striking lack of observation of the phenomena of combustion. In the course of a paper on combustion in cement burning, read before the American Institute of Mining Engineers in March and printed in the *Bulletin* for June, Mr. Eldred shows that efficiency of heat utilization in this and similar arts does not depend wholly on the thermal value of the fuel used. The form of the flame and the manner of the application of the heat to the object to be heated are matters of importance. Long-flame combustion and the application of the heating agent in contact with the work, he believes, will improve materially the economy of the cement-burning process. The plan proposed in Mr. Eldred's paper involves the separation of the process into two stages, calcining and clinkering, which are to be carried out in two separate furnaces.

"In the present practice of burning cement, the clinker is made by slowly passing a stream of finely powdered cement materials through a rotary kiln of from 5 to 8 feet internal diameter and from 60 to 150 feet long. In the entrance of the kiln burns an aerially supported flame plume, generally axially directed, produced by powdered coal injected by air. In passing through the kiln, the materials, which are an artificial or a natural mixture of clay and calcium carbonate, are first dehydrated by the heat of the flame gases. Then the carbonate is causticized by dissociation, or calcined, the carbon dioxide being driven off by heat, and finally the clay and lime unite to form the clinker.

"Each of these operations, dehydration, calcining, and clinkering, has different thermal requirements, and yet in the ordinary practice all three are performed by one flame: a flame particularly adapted to the needs of the clinkering operation and to that only. Clinkering requires a high temperature —a temperature sufficient to sinter the clay component and cause it to unite with the lime; but no great absorption of heat occurs; the action is exothermic. And as the calcines pass slowly under the blazing, heat-radiating coal flame, they rapidly acquire the necessary temperature and clinker. For the calcining, the waste heat of the flame gases is considered all that is necessary; yet the marked economy of the slow-burning, voluminous flame for calcining is well known in other arts.

"The net result is that the ordinary cement kiln is a good clinkerer, a highly inefficient calciner (the calcines often come into the clinkering zone with a material percentage of their carbon dioxide remaining), and a very wasteful thermal device." So far as combustion is concerned, the kiln is a horizontal flue, and, as in other horizontal flues, much gas stratification occurs. The gases from the flame, which is purposely spaced away from the work in the clinkering zone, rise into the arch of the kiln and never get into effective contact with the work in the calcining zone. Heating in the calcining zone is largely by radiation from the upper walls, and by direct conduction as the upper wall moves under the stream of material. Under the gases in the upper part of the kiln flows a current of relatively colder air, introduced partly by the stack suction and partly by the injector action of the flame and coal feeder.

Not only is the heating in the calcining zone inefficient; the calcination is performed under the worst possible conditions. It is a heat-absorbing reaction, and the carbon dioxide evolved, naturally a gas of high specific gravity, is relatively cold and dense, tending to remain in the bottom of the kiln as a separate stratum enveloping the material and very little admixed with the gases and air above. The carbonate is being calcined in an atmosphere at least abnormally rich in carbon dioxide, and as, within certain limits, the heat required to dissociate calcum carbonate is inversely proportional to the percentage of carbon dioxide in the atmosphere, it is easy to see why the rotary kiln is so poor a calciner in comparison with the vertical, separately fired lime kiln, in which the pieces of dissociating limestone are always bathed in a constantly changing atmosphere which can never contain more than 21 per cent. by volume of carbon dioxide, and which, as a matter of fact, never runs anywhere near as high as that amount. The sudden evolution of carbon dioxide from partially calcined material in the vicinity of the clinkering flame in the ordinary rotary kiln is the chief cause of the formation of clinker rings and nodules.

As a labor-saving device, the coal-fired rotary kiln was the greatest advance in the history of cement making; as a device for the utilization of heat, it is a grossly wasteful and inefficient apparatus. Theoretically, 25 pounds of coal should suffice for making a barrel of cement; the actual consumption is from 90 to 110 pounds. For a number of reasons, among them the transportation of dust by the gases and the necessity for unimpeded draft, it is not possible to improve heat utilization in the single kiln by the employment of regenerators, recuperators and like apparatus. The two defects of present practice in cement burning, imperfect calcination and inefficient heat utilization, can, however, be overcome by performing the two stages of calcining and clinkering as two stages in two kilns, using for each the combustion methods best adapted to the particular stage. This procedure permits the use of devices for heat recovery. The dust nuisance is obviated by the use of slow-traveling flames in both steps; the high temperature gases from the clinkering operation can be used for regenerating the fuel for clinkering, and, though less practicably, the cooler gases from the calcining kiln for regenerating for that operation. The possibility of using regenerators permits the employment as fuel of producer gas in place of the more expensive powdered coal.

The severance of the calcining operation from dependence on the clinkering process introduces the possibility of scientific heat utilization in calcination. The process becomes a simple, lime-burning step, differing only from ordinary lime burning in that the finely powdered materials cannot be handled in a vertical kiln and thus brought into actual contact with the flame and hot gases by ordinary firing means. Fine material traveling down a rotary kiln requires, however, a type of flame different from that which proves satisfactory in the boiler furnace, a flame filling the cylinder and coming into actual contact with the material to be heated and burned, instead of traveling along its top. There are long-flame fuels, but few of them can be used economically in calcining cement materials, and fewer still will give a flame capable of filling the barrel of the kiln. The flame of ordinary good producer gas is too short and scanty; if it be burned with regenerated air, as heat economy dictates, it becomes still shorter. But the long, fat flame can be secured by the simple expedient of diluting the gas with a neutral gas, or, more simply still, by diluting the air used for combustion.

Air, diluent gas and combustible gas mixed in proper proportions, when passed through a kiln containing red-hot lime, will burn and will evolve heat. Under the laws of "wall action," the burning will be most intense where the gas is in actual contact with the hot solids. By dilution of the combustible gas or the air, the flame can be made as long and as voluminous as we please. Stack gases are better for diluting purposes than even pure nitrogen, because of the greater combustion-retarding action of the carbon dioxide. By a simple adjustment of the air valve and of the stack-gas valve, the flame may be made to lengthen and spread out until it fills the kiln. It does not burn at once and give gases rising into the arch; it burns all through the kiln, and most rapidly at the point where it comes into contact with the powdered refractory material of the cement mix. The calcination of the limestone takes place in flame gases, instead of in an atmosphere of nearly pure carbon dioxide. A slow draft current through the kiln can be employed, since it is not necessary to expel the products of combustion from a zone of intense heat to make room for fresh fuel. The calcination may be accomplished without regard to clinkering zone conditions, and regulation should secure a low temperature of chimney gases, which, under present practice, carry off approximately six times the heat of the discharged clinker. Practically half the waste heat accounted for in the chimney gases is carried by the excess air required to support the combustion of powdered fuel.

The heat required for the combination of the clinker is about 15 to 18 per cent. of the heat developed by the coal. The clinkering operation conducted in a separate kiln should require but little fuel and much less attention, as good clinker depends most largely on properly calcined material. Mr. Eldred proposes, therefore, for calcination, the present rotary kiln, gas fired, with long-flame combustion. Such a kiln has produced more than 6 pounds of lime per pound of coal burned in a producer with low fuel bed. The fritted calcines are to be taken from the calcining kilns to a special clinkering kiln, embodying heat regenerators and gas firing, the clinkering process being somewhat analagous to open-hearth practice. The two-kiln process has not yet been put into commercial operation, but Mr. Eldred works out an interesting heat balance from theoretical considerations. He reaches the conclusion that it should be possible to produce nearly 7.5 pounds of cement (lime, 68.55 per cent.; silica, 20.10 per cent.; alumina, 11.35 per cent.) per pound of coal.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	Page 763	MECHANICAL ENGINEERING	Page 780
ELECTRICAL ENGINEERING	" 771	MINING AND METALLURGY	" 791
INDUSTRIAL ECONOMY	" 777	RAILWAY ENGINEERING	" 801
MARINE AND NAVAL ENGINEERING	" 778	STREET AND ELECTRIC RAILWAYS	" 805

CIVIL ENGINEERING.

BRIDGES.

Arches

Arch Coefficients. Transformation of Dimensions in Symmetrical Rib Arches; with Tables of Coefficients for Twenty Arches of Different Proportions. Malverd A. Howe. Mathematical. 2500 w. Eng News—June 2, 1910. No. 14513.

Foundations.

Foundations in the Rio Grande. George A. McKay. Explains conditions at Brownsville, Tex., in constructing a bridge across the Rio Grande, discussing the design of the foundations in quicksand. Ills. 4500 w. Harvard Engng Jour—May 1910. No. 14778 D.

Reconstruction.

Replacing a Short Truss Span by Plate Girders. Illustrates methods used on the Phila. & Read. R. R. in carrying out work without interrupting traffic. 500 w. Eng Rec—June 25, 1910. No. 15210.

See also Underpinning, under CONSTRUCTION.

Reinforced Concrete.

Methods and Cost of Constructing Three Short-Span, Single-Track Concrete Arch Bridges, Lake Champlain & Moriah Railroad. Gives methods and costs of constructing three reinforced-concrete arch bridges in northern New York. 800 w. Engng-Con—June 15, 1910. No. 14786.

Wide Span Ferro-Concrete Bridge in New Zealand. Illustrated description of a recently completed bridge in Auckland, with a span of 320 ft. 1200 w. Engr, Lond—June 17, 1910. No. 15243 A.

Recent Reinforced-Concrete Bridges (Neuere Eisenbeton-Brücken). The first part describes a single-span bridge at Kaltenthal. Ills. 1500 w. Deutsche Bau—May 25, 1910. No. 14882 B.

A New Reinforced-Concrete Bridge on the Moselle (Nuovo Ponte in Cemento armato sulla Mosella). Detailed description of a multispan arch bridge. Ills. Serial. 1st part. 5000 w. Il Cemento—May 30, 1910. No. 14851 D.

A Reinforced Concrete Bridge over the Spree at Lübben (Ponte in Cemento armato sulla Sprea a Lübben). Mathematical description of the design of truss. Ills. 2000 w. Il Cemento—May 15, 1910. No. 14849 D.

Steel.

An Early Specification for a Steel Bridge; the Glasgow Bridge Over the Missouri River. Information and general specifications for this bridge of the Chicago & Alton Ry., built in 1878. 3000 w. Eng News—June 2, 1910. No. 14511.

The Erection of the St. Paul's Missouri River Bridge. J. H. Prior. Illustrated detailed description of methods used in erecting a new bridge at Mobridge, S. Dak. 4000 w. Ry Age Gaz—June 10, 1910. No. 14681.

The Superstructure of the Mobridge Bridge on the Chicago, Milwaukee & St. Paul Railway. J. H. Prior. Drawings and detailed description of the structure and the methods of erection. Plate. 5500 w. Eng Rec—June 11, 1910. No. 14692.

Bellows Falls Arch Bridge. Joseph R. Worcester. Illustration, brief description, and information regarding this bridge across the Connecticut River. 2500 w. Jour Assn of Engng Socs—May, 1910. No. 15256 C.

The Nam-Ti Bridge. G. Bodin, in *Le Génie Civil.* Illustrated description of the bridge in Southern China, over the Nam-Ti River, and the peculiar methods employed in its construction. 1500 w. Sci Am—June 11, 1910. No. 14667.

Suspension.

Tyngs Island Bridge of the Vesper Country Club, Lowell, Mass. James W. Thomas. Illustrated description of a suspension foot bridge and its erection. General discussion. 6000 w. Jour Assn of Engng Socs—May, 1910. No. 15255 C.

Viaducts.

The Twentieth Street Viaduct, Denver, Colorado. Illustrated detailed description of a steel viaduct about 4407 ft. long. 2200 w. Eng Rec—June 4, 1910. No. 14571.

See also Elevated Railways, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS, and under STREET AND ELECTRIC RAILWAYS.

CONSTRUCTION.

Acoustics.

Architectural Acoustics. Wallace C. Sabine. A discussion of the possible effect of the motion of the air on the acoustical property of a room. 5000 w. Eng Rec—June 18, 1910. No. 14991.

Beams.

A General Criterion for Maximum Shear from a Train of Moving Loads. Lewis Jerome Johnson. A study of how to place a train of loads so as to produce a maximum shear at a given section of beam. Ills. 1500 w. Harvard Engng Jour—May, 1910. No. 14777 D.

Borings.

Uses and Methods of Preliminary Borings for Engineering Works. John P. Hogan. An illustrated account of methods, machines used, difficulties encountered, records, etc. 3000 w. Harvard Engng Jour—May, 1910. No. 14776 D.

Borings for the Panama R. R. Dock at Cristobal: With Table of Costs. E. B. Karnopp. Describes methods used, giving costs. Ills. 800 w. Eng News—June 16, 1910. No. 14906.

Coaling Towers.

A Reinforced-Concrete Locomotive Coaling Station of 2000 Tons Capacity. L. M. Ewell. Illustrated detailed description of a new coaling station in Philadelphia. 2500 w. Eng News—June 23, 1910. No. 15133.

Concrete.

Office Methods in a Concrete Designing Office. Describes the system and forms adopted by the Eastern Concrete Construction Company of Boston. 2500 w. Eng Rec—June 11, 1910. No. 14691.

The Construction of Concrete Fence Posts. Considers their advantages and making, and the principles involved. Ills. 9500 w. U S Dept of Agri—Farmers' Bul. 403. No. 14781 N.

The Use of Concrete in Farm Buildings from a Sanitary Standpoint. S. Cunningham, Jr. Discusses details of such buildings. 2200 w. Cement Age—June, 1910. No. 15041.

Concrete Features of the Toledo Filtration Plant. B. M. Baker. Brief description of this fine plant, especially the concrete features. Ills. 3500 w. Cement Age—June, 1910. No. 15040.

Concrete Mixers.

Concrete-Making Machinery. Vere Sussex Hyde. Illustrations with description of the chief features of the principal machines being used in England. 2500 w. Surveyor—June 17, 1910. No. 15231 A.

Earthwork.

Earthwork Shrinkage, Application and Amount. E. B. Espenshade. Discusses how much earthwork shrinks and the comparison of excavation and embankment quantities. 2500 w. Engng-Con—June 1, 1910. No. 14552.

Economies.

Structural Economy. E. A. Slater. Suggests methods by which economies can be effected in various kinds of engineering work. 5000 w. Surveyor—June 3, 1910. No. 14738 A.

Factories.

Modern Factory Construction (Der moderne Fabriksbau). Joseph Aug. Lux. A plea for æsthetic treatment of factory structures. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 28, 1910. No. 15050 D.

Floors.

Concrete and Tile Floors, with Two-Way Reinforcement. Illustrated description of the Burchartz system, a new type of construction used in America, and brief notice of the Aragon system, used in France. 1200 w. Eng News—June 16, 1910. No. 14912.

Foundations.

The Ultimate Load on Pile Foundations: A Static Theory. John H. Griffith. Criticisms of the static method as it has been presented with an outline of views as to its development along rational and empirical lines. 10500 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14941 E.

Pneumatic Caisson Foundations, Whitehall Building, New York. Illustrated description of foundation work for a 32-story extension to a 20-story building. 3000 w. Eng Rec—June 18, 1910. No. 14996.

Artificial Foundations (Procédé de Fondation par Compression mécanique du Sol). P. Ossent. Describes the "Compressol" system of pile foundations. Ills. Serial. 1st part. 3200 w. Bul Tech d l Suisse Romande—May 25, 1910. No. 14833 D.

Pile Cutting.

Under-Water Pile Saw with Guide Bracket for Cutting to Even Grade. Clarence Coleman. Illustrated description of a pile-cutting machine used at Superior Entry, Wis. 800 w. Eng News—June 16, 1910. No. 14909.

Piling.

Pile Statics (Zur Frage der Pfahlstatik). A criticism of Herr Stern's recent paper by Herr Jacoby, with a reply by the former. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—May 14, 1910. No. 14898 D.

Piling and Trestling. F. R. Archibald. Read before the Nova Scotia Soc. of Engrs. Considers various kinds of piling, its uses and costs; deterioration; and temporary trestling. 2000 w. Can Engr—June 16, 1910. No. 14980.

Sheet Steel Piling. J. F. Springer. Illustrates and describes special forms of piling for aqueous construction, discussing early methods in the present number. 6000 w. Cassier's Mag—June, 1910. Serial. 1st part. No. 14841 B.

Reinforced Concrete.

A Few Notes on the Design of Reinforced Concrete. Considers points in practical building construction from the standpoint of the designer. 3000 w. Minn Engr—May, 1910. No. 14766 C.

Diagrams for Designing Reinforced Concrete Beams. Frank H. Carter. Diagrams, with explanatory notes. 700 w. Eng Rec—June 18, 1910. No. 14993.

A Graphical Chart for the Determination of Stresses in the Concrete and Reinforcement in Concrete Beams (Graphische Tabelle zur Ermittelung der Betonspannungen und der Eiseneinlagen in Eisenbetonunterzügen). Rob. Müller. Mathematical explanation of a chart based on the Prussian regulations. 1500 w. Deutsche Bau—May 14, 1910. No. 14881 B.

The Calculation of Stresses Due to Bending in Masonry and Reinforced-Concrete Structures (Beitrag zur Berechnung der Biegungsspannungen in Stein- und Betonkonstruktionen). W. Carling. A review of various theories. Ills. Serial. 1st part. 1200 w. Beton u Eisen—May 14, 1910. No. 15056 F.

Improving the Transverse Strength of Reinforced-Concrete Beams (Zur Aufnahme der Querkraft in Eisenbetonbalken). Herr Hotopp. Discusses the location of reinforcement for maximum strength. Ills. 3200 w. Beton u Eisen—May 14, 1910. No. 15055 F.

Construction of a Large Reinforced-Concrete Grandstand. The grandstand at the Minnesota State Fair race-track, St. Paul, is illustrated and its construction described. 2500 w. Eng Rec—June 4, 1910. No. 14572.

Multistory Frame Construction (Mehrstöckige Rahmenkonstruktionen). F. Baumstark. Mathematical. Ills. 3500 w. Beton u Eisen—May 14, 1910. No. 15051 F.

Reinforced-Concrete Construction in the Extension of the Bismarck Secondary School, Stettin (Die Eisenbetonkonstruktionen in dem Neubau der Bismarck-Realschule in Stettin). Herr Weidmann. Mathematical discussion of some of the construction details. Ills. 4000 w. Beton u Eisen—May 14, 1910. No. 15053 F.

See also Coaling Towers, under CONSTRUCTION; Siphons, and Tanks, under WATER SUPPLY; and Wharves, under WATERWAYS AND HARBORS.

Skyscrapers.

The New York Skycrapers. Thaddeus S. Dayton. Gives interesting facts regarding the era of tall buildings. 1800 w. Ir Age—June 16, 1910. No. 14900.

Steel.

The Calculation of Rolled Sections under the New German Regulations (Die Berechnung der Walzträger nach den neuen ministeriellen Bestimmungen). Herr Weidmann. Discusses particularly the effect of the new regulations on I-beam design. Ills. 2500 w. Stahl u Eisen—May 4, 1910. No. 14858 D.

Some Formulas for Statically Indeterminate Members and Frames. C. T. Mitchell. Gives formulas proposed as an aid in the analysis of moment stresses in single members or in rigid framed bents due to eccentric loading. 4000 w. Eng News—May 26, 1910. No. 14402.

The Design of Wall Bearings for H. S. Joists. T. McGill. Illustrated discussion of the length and area of bearing surfaces for beams or girders, the safe loads, etc. 1000 w. Prac Engr—May 20, 1910. Serial. 1st part. No. 14457 A.

A Narrow Twelve-Story Building. John S. Branne. Illustrates and describes a building in New York City, erected on a plot 22 ft. 3 ins. wide at one end and less than 20 ft. at the other. 1500 w. Eng News—May 26, 1910. No. 14404.

Tunnels.

The Metropolitan of Paris (Lé Metropolitain de Paris). P. Calfas. Describes the construction under the Seine of line No. 4, in which both the shield and freezing methods were used. Ills. 5000 w. Génie Civil—May 21, 1910. No. 14840 D.

See also same title, under WATER SUPPLY.

Underpinning.

Shoring Channel Span, South 22d Street Bridge, Pittsburg. Describes conditions that made necessary the replacing of river piers, and gives illustrated description of methods of supporting the superstructure. 2500 w. Eng Rec—May 28, 1910. No. 14414.

Waterproofing.

Waterproofing of Engineering Structures. Joseph H. O'Brien. Presents points of general interest and describes waterproofing by use of pitch and felt. Ills. Discussion. 7000 w. Jour Assn of Engng Socs —May, 1910. No. 15257 C.

Wrecking.

Wrecking the Gillender Building, New York. An illustrated account of the wrecking of a tall, steel-frame building in New York City. 1800 w. Eng Rec—June 11, 1910. No. 14689

MATERIALS OF CONSTRUCTION.

Cement.

The New German Standard Specifications for Cement. H. Burchartz. Gives the requirements. Ills. 3500 w. Eng Rec —June 25, 1910. No. 15209.

A Microscopic Study of an Italian Natural Portland Cement (Studio Microscopico di un Portland naturale Italiano). Silvio Bosio. Illustrated with microphotographs. Serial. 1st part. 2700 w. Il Cemento—May 15, 1910. No. 14850 D.

Concrete.

Engineering Work in Concrete. Day Allen Willey. Illustrated review of the extending uses of this material in construction work. 4500 w. Cassier's Mag—June, 1910. No. 14639 B.

"What Are the Facts Respecting the Disintegration of Concrete by Sea Water, Alkali, Sewage, Etc." Summary of what is known in regard to this subject. 2500 w. Engng-Con—June 15, 1910. No. 14785.

Reinforced Concrete.

The Formation of Cracks in Reinforced Concrete (Einiges zur Rissbildung des Eisenbetons). Otto Graf. A discussion of the causes of cracks. Ills. Serial. 1st part. 2000 w. Beton u Eisen—May 14, 1910. No. 15052 F.

Steel.

The Application of Steel in Building Construction (Die Verwendung von Eisen im Hochbau). Herr Fischmann. Discusses steel sections, cost of materials, the structural-steel trade, etc. Ills. 1000 w. Stahl u Eisen—May 11, 1910. No. 14861 D.

Stucco.

Modern Stucco Work. Albert Moyer. Information in regard to its application and the production of artistic effects. 2000 w. Eng Rec—June 18, 1910. No. 14994.

MEASUREMENT.

Hydrographic Surveying.

The U. S. Lake Survey. M. S. MacDiarmid. Describes the work and methods. The main object being to prepare accurate navigator's charts. Ills. 2500 w. Cornell Civ Engr—June, 1910. No. 15043 C.

Surveying.

Methods and Costs of Railroad Surveys in Bolivia. C. A. Bock. Map and report of exploratory surveys and reconnoissance work. 3500 w. Eng Rec—June 25, 1910. No. 15206.

MUNICIPAL.

Barrow-in-Furness.

Barrow-in-Furness and Some of Its Municipal Undertakings. Arthur Race. Gives the principal industries, describing streets, street-lighting, refuse destructors, bridges, abattoirs, sewerage works, etc. Ills. 9000 w. Surveyor—June 10, 1910. Serial. 1st part. No. 15034 A.

City Planning.

Corey: Model City from the Ground Up. Albert Phenis. An illustrated description of a city being built in Alabama, to furnish healthful homes for the steel workers and allied industries. 2500 w. Mfrs' Rec—June 2, 1910. No. 14494.

Drainage.

The Glarus Drainage Works (Die Kanalisation der Stadt Glarus). H. Schleich.

Describes a storm-water drainage system. Ills. 3200 w. Schweiz Bau—May 14, 1910. No. 14883 B.

Pavements.

Influence of Tramways on Street Paving. R. O. Wynne-Roberts. Discusses the points in tramway and pavement construction that are of importance to road engineers. 5000 w. Surveyor—May 27, 1910. No. 14612 A.

Brick Paved Highways. W. P. Blair. Read before the Nat. Brick Mfrs. Assn. Discusses the proper construction. Ills. 3500 w. Munic Engng—June, 1910. No. 14926 C.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Gives a general description of the results obtained in some of the large towns of England by utilizing heat from refuse destruction. 1800 w. Munic Engng—June, 1910. No. 14924 C.

The Design and Working of a Modern Refuse Destructor. William F. Loveday. Gives a summary of the essential principles of refuse destructor design and describes a recent installation in England. 2000 w. Eng News—June 23, 1910. No. 15132.

See also Central Stations, under ELECTRICAL ENGINEERING, Generating Stations.

Road Rollers.

Road Rollers Driven by Combustion Motors (Note sur les Rouleaux Compresseurs avec Moteurs à Mélange tonnant). M. Bret. Discusses their economy and advantages over steam rollers. Ills. 6000 w. Ann d Ponts et Chaussées—1910—II. No. 14804 E + F.

Roads.

Width of Roads. F. W. W. Doane. Discusses the unnecessary width of country roads and town streets. 2000 w. Can Engr—June 23, 1910. No. 15195.

Sand-Clay Roads. How to make good country roads on sand or clay soil. 2000 w. Munic Jour & Engr—June 15, 1910. No. 14783.

Road Construction and Maintenance. R. F. Grantham. A discussion of modern practice in construction, surface-treatment, requirements of new traffic, and related subjects. 4000 w. Surveyor—May 20, 1910. No. 14460 A.

The Management and Improvement of Rural District Roads. E. K. Dixon. Read before the Irish Road Cong. Discusses administration methods and suggests improvements. 3500 w. Surveyor—June 17, 1910. No. 15232 A.

The Need for Good Roads in the South. Lawrence C. Witten. Reviews the good roads movement in a number of southern states. 3000 w. Mfrs' Rec—June 23, 1910. No. 15109.

Road Work in Newton, Massachusetts. Edwin H. Rogers. Illustrates and describes methods of dust laying and roadway surfacing, giving costs of various treatments. 1800 w. Munic Jour & Engr —June 15, 1910. No. 14784.

Road Treatment in Eastern Massachusetts. Illustrated account of methods, costs, and apparatus used. 5500 w. Munic Jour & Engr—June 15, 1910. No. 14782.

The Waterproofing of Road Surfaces. George W. Manning. Read before the Inc. Assn. of Munic. & Co. Engrs. Deals only with highways, discussing the applications of various materials. 2000 w. Surveyor—May 20, 1910. No. 14459 A.

A Few Remarks in Regard to Surface-Spraying of Roads with Tar and Making in Situ Tar-Macadam. T. Aitken. Discusses the benefits resulting, the methods to ensure success, cost, etc. 2200 w. Surveyor—May 20, 1910. No. 14458 A.

Sewage Disposal.

Individual Sewage Purification Plant. Shows a combined septic tank and filter which requires very little attention. 1700 w. Met Work—June 18, 1910. No. 14964.

Degree of Purification of Sewage by Screens and Grit Tanks and Methods and Costs of Purifying Sewage to Higher Degree Than by Fine Screens. From notes supplementing the report on the Disposal of Sewage of the City of Rochester, N. Y., made by E. Kuichling. 5000 w. Engng-Con—June 22, 1910. No. 15123.

Reports on the Disposal of the Sewage of the Calumet District of Chicago and Its Relation to the Chicago Drainage Canal. Abstract of the report of the Committee on Engineering, with letters. Also editorial 6000 w. Eng News—June 16, 1910. No. 14911.

Flushing the West Branch of Bubbly Creek, Chicago. Drainage from large sewers and some surface wash are received by this stream which has little or no current and is practically an open septic tank with a very long period of flow The arrangements for flushing are illustrated and described. 1600 w. Eng Rec—June 11, 1910. No. 14687.

A Short Treatise on the Sewage Disposal Plant of Baltimore City. G. J. Reguardt. Describes the character of the sewage and the processes to which it will be subjected. Ills. 2500 w. Cornell Civ Engr—June, 1910. No. 15045 C.

Sewerage and Sewage Disposal Works. Lichfield. W. B. Chancellor. Describes a plant using the continuous-flow filter and fixed spray distribution. 1500 w. Can Engr—May 27, 1910. No. 14488.

The New Sewerage System of Louisville, Ky. Diagram, map and general description. 3000 w. Engng-Con—June 8, 1910. No. 14656.

The Glasgow Main Drainage and Sewage Disposal Works. An account of the electrical features, including electric pumping, an electricity supply station, and special electrical plant for clearing the catchpit. Ills. 2200 w. Elect'n, Lond—June 3, 1910. No. 14731 A.

The New Sewage Experiment Station of the Massachusetts Institute of Technology. C.-E. A. Winslow, and Earle B. Phelps. Plan and description of the new plant at Old Harbor Point in Dorchester. Ills. 2200 w. Eng News—June 2, 1910. No. 14516.

Sewage Pumping.

Sewage Pumping Appliances. George T. Hammond. A statement of the principles of sewage pumping. 4000 w. Munic Jour & Engr—June 8, 1910. No. 14655.

Sewers.

Sewer Interceptors at Columbus. Julian Griggs. Explains the reason for constructing relief sewers, and gives illustrated description of the new gate interceptors. 1500 w. Munic Jour & Engr—June 1, 1910. No. 14493.

Drainage Improvement and Intercepting Sewer System for Syracuse, N. Y. Glenn D. Holmes. The substance of a lecture before the College of Civil Engng, Cornell University. Description of the work. Ills. 4000 w. Cornell Civ Engr—June, 1910. No. 15042 C.

Details of the Design of the Sewers of Louisville, Ky. Illustrates and describes interesting details of this extensive sewer work. 3500 w. Engng-Con—June 15, 1910. Serial. 1st part. No. 14787.

Stone Crushing.

A Modern Stone Crushing Plant of 600 Cu. Yds. Capacity Per Hour—Some Costs of Drilling, of Maintenance of Plant, and of Erecting Machinery. Illustrated description of a plant near Chicago, and information relating to its equipment and operation. 3000 w. Engng-Con—June 1, 1910. No. 14551.

A New Type of Stone Crusher. Illustrated description of the Symons disk crushing machine. 1000 w. Eng News—May 26, 1910. No. 14407.

Street Prolongation.

The Elongation of the Rue de Rennes, Paris, and the Project for an X Bridge Over the Seine (Le Prolongement de la Rue de Rennes, à Paris, et le Projet de Pont en X sur la Seine). E. Hénard. A discussion of traffic congestion in Paris and suggested means of improvement. Ills. 3500 w. Génie Civil—May 14, 1910. No. 14830 D.

Street Traffic.

Chicago Traffic Conditions in the Congested District. Extracts from a report showing how the problem was studied. 2000 w. Eng Rec—June 4, 1910. No. 14568.

WATER SUPPLY.

Aqueducts.

See Tunnels, under Water Supply.

Conduits.

See Dams, under Water Supply.

Dams.

Experiments with a Model of the Gatun Spillway. Edward C. Sherman. Explains the design and purpose of the spillway and gives illustrated description of the experiments made on the model. 1700 w. Eng Rec—June 4, 1910. No. 14567.

An Arch Dam Design for the Site of the Shoshone Dam. John S. Eastwood. A criticism of the design of this dam, based on a description by H. N. Savage, and describing a proposed arch design. Ills. 2500 w. Eng News—June 9, 1910. No. 14666.

Dams with Overhung Batter. Robert H. Smith. Mathematical demonstration to show the erroneousness of the idea that a dam is given greater stability by giving its face a positive batter. 2000 w. Engr, Lond—May 27, 1910. No. 14626 A.

Concrete Dam and Conduit. Illustrates and describes work in connection with the Maiden Creek water supply of Reading, Pa. 4800 w. Munic Jour & Engr—June 1, 1910. No. 14492.

Evaporation.

Records of Evaporation Obtained at 23 Different Stations in Various Parts of the United States. Advance summary of data thus far gathered by the Government. 1800 w. Eng News—June 16, 1910. No. 14908.

Filtration.

Mechanical Gravity Filters. W. H. Humphreys. Presidential address before the Assn. of Water Engrs. at York, Eng. General discussion of mechanical gravity filters, and report of the installation at the York water-works. 4000 w. Surveyor—June 3, 1910. No. 14739 A.

See also Concrete, under Construction.

Fire Protection.

Fire Fighting Without Fire Engines. Herbert T. Wade. Illustrated description of methods and applications of the high-pressure fire service. 1700 w. Sci Am—June 4, 1910. No. 14505.

Ground Waters.

The Utilization of Ground Water, with Special Reference to the Rand Water Board's Wells in the Dolomite. D. C. Leitch. Considers the Transvaal law in respect to ground water, and describes the works, and location of the wells. Ills. 7000 w. Jour S African Assn of Engrs—April, 1910. No. 14606 F.

Preliminary Investigations for the Increase of the Czernowitz Water Supply (Die Vorarbeiten für die Erweiterung der Wasserversorgung der Stadt Czernowitz). G. Thiem. Describes an investigation of ground-water supplies. Ills. 5000 w. Oest Wochenschr f d Oeffent Baudienst—May 14, 1910. No. 14897 D.

Illinois.

Chemical and Biological Survey of the Waters of Illinois. Report for year ending Dec. 31, 1908, which includes a brief description of work done during the year, and articles describing work at the laboratories, of difficulties with incrustation, investigations of farm water supplies and other subjects. Ills. 48000 w. Univ of Ill. Bul—Sept. 13, 1909. No. 14647 N.

Intakes.

Two Power-Plant Intakes at St. Louis. Notes from a paper by John Hunter, before the N. E. L. A. concerning the Ashley St. and Lewis St. intakes. Ills. 3000 w. Eng Rec—June 25, 1910. No. 15207.

Cooling-Water Intakes from the Mississippi River for Two Power Stations. John Hunter. From a paper before the Nat. Elec. Lgt. Assn. Illustrated description of the condenser supply systems of the two power stations of the Union Elec. Lgt. & Power Co. on the west bank of the river at St. Louis. 3000 w. Eng News —June 9, 1910. No. 14662.

Irrigation.

Field Work in Locating Irrigation Ditch and Canal Lines. Albert B. Bartlett. Describes methods used in the design of irrigating systems. 2000 w. Eng News—May 26, 1910. No. 14403.

The Cost of U. S. Reclamation Works. A statement before the House Committee on Irrigation by Director F. H. Newell of the U. S. Reclamation Service. 3300 w. Eng Rec—June 11, 1910. No. 14695.

An Example of Irrigation in Texas. H. V. Watts. Describes the irrigation system of San Benito. 2500 w. Mfrs' Rec—June 2, 1910. No. 14495.

Engineering Progress in Egypt and the Soudan. An outline of the progress of public works, based on the report of Sir Eldon Gorst. 1200 w. Engr, Lond—May 20, 1910. No. 14474 A.

London.

The Metropolitan Water Supply. E. Bailey-Denton. A discussion of the London water supply. 2000 w. Engr, Lond—June 17, 1910. No. 15241 A.

Pipe Laying.

Laying a 48-Inch Main Under Water. Illustrated description of the laying of this large main under the Harlem River, connecting Manhattan and the Bronx. 600 w. Pro Age—June 15, 1910. No. 14762.

Purification.

The Disinfection of Polluted Water. Clyde Potts. Discusses especially the use of chlorine for this purpose. 2200 w. Cornell Civ Engr—June, 1910. No. 15044 C.

Use of Hypochlorite in Connection with Pre-Filtration. Francis D. West. Describes an incompleted test to demonstrate that hypochlorite is not a panacea for all "water ills." 1200 w. Eng Rec—June 25, 1910. No. 15208.

Report on the Lindsay Ozone Water Purification Plant. Information from a recent report published by the Provincial Government of Ontario. Ills. 2000 w. Can Engr—June 3, 1910. No. 14591.

Reservoirs.

Reinforced Concrete Reservoirs. J. B. Henson. Read before the Northern Engng. Inst. (N. S. W.). Describes the Pelow Main reservoir and the Neath reservoir (N. S. W.). Diagram. 2000 w. Aust Min Stand—May 4, 1910. No. 14602 B.

The Western High-Service Reservoir of the Water Works of Baltimore, Md. Alfred M. Quick. Explains conditions and gives illustrated detailed description of a new reservoir of about 210,000,000 gals. capacity. 4500 w. Eng News—May 26, 1910. No. 14400.

Siphons.

A Method of Design of a Reinforced Concrete Siphon. J. Ralph Van Duyne. States the conditions and gives diagrams and description of method used. 2500 w. Eng Rec—May 28, 1910. No. 14418.

Sterilization.

The Sterilization of Water by Means of Chloride of Lime (La Stérilisation de l'Eau d'Alimentation au Moyen du Chlorure de Chaux). G. Dupont. Describes the plant and practice at Montreal, Canada. Ills. 3000 w. Génie Civil—May 7, 1910. No. 14836 D.

Swimming Pools.

Water Supply to a Swimming Pool. Illustrates and describes features of water purification and heating at John Jacob Astor's estate at Rhinebeck, N. Y. 2500 w. Met Work—June 25, 1910. No. 15193.

Tanks.

Perpendicular Reinforcement of the Walls of Cylindrical Tanks (Die lotrechte Bewehrung der Zylindrischen Behälterwand). Max Mayer. Mathematical, developing formulae. Ills. 3500 w. Beton u Eisen—May 14, 1910. No. 15054 F.

Tunnels.

Report on the Proposed Board of Water-Supply Pressure Tunnel Beneath New York City. Brief historical account of the project, with presentation of estimates and discussion of this and other distribution plans. 4000 w. Eng News—June 2, 1910. No. 14517.

The Moodna Pressure Tunnel of the Catskill Aqueduct. Illustrated description of its construction and power plant. 3000 w. Eng Rec—June 4, 1910. No. 14570.

The New Buffalo Water-Works Tunnel. F. Lavis. Illustrated description of methods of driving and lining a hard rock tunnel under compressed air. Also editorial. 6500 w. Eng Rec—June 25, 1910. No. 15204.

Typhoid.

The Maidstone Typhoid Epidemic. William P. Mason. An account of a serious typhoid epidemic in England, and its cause. Ills. 1200 w. Jour N Eng W-Wks Assn—June, 1910. No. 14937 F.

Water-Works Depreciation.

Depreciation in Water-Works Accounts. With Reference to Uniform Reports. Harvey S. Chase. Discusses the computation of depreciation and the best way to handle these matters. General discussion. 9000 w. Jour N Eng W-Wks Assn—June, 1910. No. 14938.

Water-Works Valuation.

Decision of the Railroad Commission of Wisconsin in the Appleton Water-Works Case. Discusses the subject of deriving fair valuations of such properties. 4000 w. Eng News—June 16, 1910. No. 14910.

Wells.

A Deep Well Sunk by Caisson. Illustrated description of a deep well to furnish domestic water supply at Long Beach, Long Island, N. Y. 1000 w. Eng Rec—May 28, 1910. No. 14416.

WATERWAYS AND HARBORS.

Barge Canal.

The Terminals of the New York State Barge Canal; Preliminary Report of the Terminal Commission. The preliminary report of the Commission appointed by the Legislature to investigate the matter. 900 w. Eng News—May 26, 1910. No. 14408.

The New York State Barge Canal. An illustrated description of the general design of the canal and the structures upon it, with a brief account of the progress of the work. 6500 w. Eng News—June 9, 1910. No. 14661.

Breakwaters.

Breakwaters at Vornpör and Hanstholm, Jutland. Illustrated description of recently constructed breakwaters for the protection of fishermen and to prolong the fishing season. 1800 w. Engng—May 27, 1910. No. 14617 A.

Canals.

The Stockton, California, Diverting Canal. An account of an improvement to prevent silting of a navigable channel, and also to prevent floods. 1500 w. Eng Rec—June 18, 1910. No. 14902.

Coaling Stations.

The Naval Coaling Station at Tiburon, California. Illustrated description of a Double-deck structure having a capacity of about 500 tons per hour. 1200 w. Eng Rec—May 28, 1910. No. 14421.

Docks.

Pontoon Method of Subaqueous Concrete Construction. Photographs, diagrams, and brief description of method adopted at Goderich, Ont., for dock extension. 500 w. Can Engr—June 10, 1910. No. 14685.

A Modern Type of Dock Construction. Harrison L. Garner. Illustrated detailed description of the construction of a reinforced-concrete dock on the Chicago river. 1800 w. Wis Engr—June, 1910. No. 14928 D.

The East Boston Docks. Howard K. Alden. Illustrated description of the Boston & Albany Railroad improvements. 1500 w. Harvard Engng Jour—May, 1910. No. 14780 D.

Flood Prevention.

See Canals, under WATERWAYS AND HARBORS.

Georgian Bay Canal.

The Georgian Bay Ship Canal. Map and information concerning the proposed canal to furnish a shorter route between the Great Lakes and the St. Lawrence River. 3000 w. Engng—May 20, 1910. No. 14464 A.

International Waterways.

A Treaty for the Control of International Waterways. Gives the provisions of most interest to engineers in the "Waterways Treaty" between the United States and Great Britain, for fixing the international boundary between the United States and Canada, and for determining the disposition of all boundary differences. 800 w. Eng News—June 9, 1910. No. 14659.

Lighthouses.

Building the Miah Maul Shoal Lighthouse. Thomas J. Rout, Jr., and A. E. Arledge. Illustrated detailed description, and general information concerning this lighthouse in Delaware Bay. 1800 w. Eng News—June 2, 1910. No. 14510.

Method of Lighthouse Illumination (Différents Modes d'Eclairage des Phares). M. J. Bénard. An exhaustive consideration of lamps, searchlights, reflectors, projectors, etc. Ills. 14000 w. Mem Soc Ing Civ de France—March, 1910. No. 14810 G.

Locks.

The Operation of Locks with Lateral Reservoirs (Wie kann bei Schleusen mit Sparbecken der Betrieb beschleunigt werden?). E. Beyerhaus. Suggestions for securing more rapid operation. Ills. 3200 w. Zeitschr d Oest Ing u Arch Ver—May 27, 1910. No. 14896 D.

Panama Canal.

Present Conditions at Panama. A review of progress made in the construction of the ship canal, with map, profile, cross-sections and illustrations. 2800 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14623 A.

Piers.

Reinforced Concrete Pier Construction. Eugene Klapp. Illustrated detailed description of a private yacht pier, built near Glen Cove, Long Island. 2500 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14939 E.

Concrete Piers, Port of Genoa. Brief description of interesting repair work recently completed. 600 w. Engng—May 20, 1910. No. 14469 A.

Pollution.

The Metropolitan Sewerage Commission Against the Discharge of Treated Passaic Valley Sewage Into New York Bay. A report addressed to the Mayor of the City of New York, with editorial criticism. 2500 w. Eng News—June 9, 1910. No. 14660.

Rotterdam.

The New Waterway to Rotterdam 1879-1908 (Der neue Wasserweg nach Rotterdam 1879 bis 1908). A. von Horn. A review of the developments of the last thirty years. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—May 21, 1910. No. 14899 D.

Russia.

Interior Navigation in Russia (La Navigation intérieur en Russie). M. Bourgougnon. A report of the discussion at the Inter. Navigation Congress, St. Petersburg, 1908. Ills. 8800 w. Ann d Ponts et Chaussées—1910-II. No. 14806 E + F.

Russian Mercantile Harbors (Ports de Commerce de la Russie). M. G. de Joly. A review of the harbors and harbor works, traffic, administration, etc. Ills. 8500 w. Ann d Ponts et Chaussés—1910-II. No. 14807 E + F.

Silt.

The Silt Problem: Kaw River. Herman Stabler and Horatio N. Parker. A study of this river in Kansas as an illustration of methods that may be used to avoid large errors in the solution of engineering problems. 2000 w. Eng News—June 2, 1910. No. 14514.

Sluice Gates.

Some Notes on Sliding Sluice Gates, Charles River Basin, Boston -Cambridge, Mass. Walton H. Sears. A record of the Commission's experience to date with the cast-iron bronze-faced gates installed. Ills. 1800 w. Eng News—May 26, 1910. No. 14406.

Soerabaja.

The Harbor of Soerabaja (Het Havenplan voor Soerabaja). J. Kraus and C. J. de Jongh. Two short papers on this important port in Java. Ills. 5000 w. De Ingenieur—May 28, 1910. No. 15083 D.

Tacoma.

Commencement Bay, the Harbor of Tacoma. Louis P. Zimmerman. Fifth of series of articles describing the principal harbors of the Pacific coast. Ills. 4000 w. Marine Rev—June, 1910. No. 14969.

Water Powers.

The Effect of Recent Engineering Progress in Reducing the Value of Water Power. Editorial, showing the importance of correct understanding of the value of water-power, discussing the advantages of the steam-turbine electric station over the hydro-electric station, and the difficulties and limiting conditions of water-power plants. 3000 w. Eng News—June 23, 1910. No. 15134.

Governmental Regulation of Water Powers. Marshall O. Leighton. Reviews some European legislation bearing on water-power control. Discussion. 7000 w. Jour N Eng W-Wks Assn—June, 1910. No. 14935 F.

The Economic Importance of the Austrian Alpine Water Powers (Die kaufmännische Bedeutung der österreichischen Alpenwasserkräfte, ihre Rentabilität, Finanzierung und Besteuerung). Walter Conrad. A discussion of economical and rational methods of utilization. Ills. Serial. 1st part. 5000 w. Elektrotech u Maschinenbau—May 29, 1910. No. 15070 D.

Wharfs.

A New Reinforced-Concrete Wharf on the Guadalquivir, near Seville (Nouvel Appontement en Béton armé sur le Guadalquivir près de Séville, Espagne). Juan Manuel de Zafra. Describes a trestle wharf for the shipment of 2,000 tons of ore per day. Ills. 3500 w. Génie Civil—May 14, 1910. No. 14838 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

New Wireless Telegraphy and Telephony Instruments. Illustrated description of the Helsby instruments and account of the recent demonstration at the Crystal Palace, London. 2000 w. Engr, Lond—May 27, 1910. No. 14627 A.

The Helsby Wireless Telegraph and Telephone Systems. Brief illustrated description of apparatus used. 400 w. Elect'n, Lond—May 27, 1910. No. 14609 A.

Some Experiments with the New Telefunken System. Graf Arco. Describes a number of experiments and shows how messages from two sending stations can simultaneously be picked up by one receiver. Ills. 2500 w. Elect'n, Lond—June 10, 1910. No. 15031 A.

Wireless Telegraphy for Marine Inter-Communication. W. W. Bradfield. Discusses the advantages, and gives illustrated detailed description of the various parts of the Marconi plant used on board ship. 3500 w. Elect'n, Lond—June 10, 1910. No. 15029 A.

Radiotelegraphy Masts.

Erection of an 80-Metre Timber Mast and Tests on Doubled and Reinforced Timber Beams (Errichtung von 80 m hohen Holzmasten und Versuche mit verdübelten und verstärkten Balken). Herr Lengeling. Describes the construction and erection of the mast. The beam tests were on a number of bridge members made by combining two parts of the same section and reinforced in various ways. Ills. 4000 w. Glasers Ann—May 1, 1910. No. 14890 D.

Telephone Rates.

The Typical Rate Problem in Small Telephone Properties. Frank F. Fowle. The present number gives statistics and information relating to "Independent" development. 1000 w. Elec Rev, N Y—June 4, 1910. Serial. 1st part. No. 14583.

Telephonic Stethoscope.

A Telephonic Stethoscope. Illustrates and describes an interesting device invented by S. G. Brown. 1700 w. Sci Am —June 18, 1910. No. 14914.

Telephony.

The Telephone Industry of the World. Gives statistics showing the United States far in the lead of all countries. 2000 w. Elec Rev, N Y—June 25, 1910. No. 15203.

Telephone Engineering Around the Golden Gate. Arthur Bessey Smith. An account of the engineering problems of Oakland and San Francisco, and how they were solved. Ills. 6000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14958 F.

Telephone Circuits. Prof. J. Perry. Read before the Phys. Soc. Gives an easy method of calculation for the spacing of Pupin coils. 3500 w. Elect'n, Lond—May 20, 1910. No. 14449 A.

The Telephone and Its Relation to Electric Tramways (Le Téléphone et ses Rapports avec les Tramways électriques). M. Henrion. A discussion of telephone systems utilizing tramway rails for the return current. Ills. 6000 w. Soc Belge d'Elecns—May, 1910. No. 14800 E.

See also Ships' Telephones, under MARINE AND NAVAL ENGINEERING.

DISTRIBUTION.

Fuses.

Standardization of Fuses. H. W. Kefford. Abstract of a paper read before the Inst. of Elec. Engrs. Discusses the most suitable quantitive and structural properties for a standard line of fuses. 6000 w. Elec Engr, Lond—May 27, 1910. No. 14608 A.

Industrial Plants.

Electrical Distribution of Energy in Industrial Plants. George R. Terry. Describes a system that has been adopted throughout several industrial mill properties. 1200 w. Elec Wld—June 23, 1910. No. 15140

Wiring Conduits.

Strap Iron Supports for Conduit. George S. Mason. Methods of erecting multiple conduit runs are illustrated and described. 1600 w. Elec Wld—June 2, 1910. No. 14504.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Synchronizing Alternators. S. G. Winn. Considers the operation of alternators in parallel. Ills. 2500 w. Cassier's Mag—June, 1910. No. 14640 B.

A. C. Motors.

Buying Alternating-Current Motors. H. M. Phillips. Suggestions for the selection of reliable motors. 3000 w. Elec Age—May, 1910. No. 14409.

Short-Circuit Losses in Alternating-Current Commutator Motors. A. Fraenckel, and B. J. M. Lane. Gives results of experimental researches on the losses due to the short-circuit currents. 1800 w. Elect'n, Lond—May 20, 1910. Serial. 1st part. No. 14450 A.

The Three-Phase Series Commutator Motor (Zur Theorie des Drehstrom-Serienkollektormotors). L. Dreyfus and F. Hillebrand. A theoretical discussion. Ills. 4500 w. Elektrotech u Maschinenbau—May 1, 1910. No. 15064 D.

Contribution to the Study of Asynchronous Motor by Means of the Circle Diagram (Contribution à l'Etude des Moteurs asynchrones par le Diagramme du Cercle). J. Yernaux. Mathematical. Ills. 1000 w. Soc Belge d'Elecns—May, 1910. No. 14801 E.

Bearings.

The Origin and Prevention of Currents in Bearings. L. Alder. Abstract from *Electrotechnik and Maschinenbau.* Discusses the causes of currents in the bearings of electric machines, and how the nuisance can be avoided. 2000 w. Elect'n, Lond—June 3, 1910. No. 14732 A.

Brushes.

Electrical Characteristics of Carbon Brushes. Jay L. Smith. Describes and shows graphically experimental results obtained from sample brushes. 2500 w. Sib Jour of Engng—June, 1910. No. 14934 C.

Cooling.

Air Filters for Turbodynamos (Luftfilter für Turbodynamos). K. Hoefer. A description of air-cooling devices. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—May 30, 1910. No. 14880 D.

D. C. Dynamos.

Methods of Deriving the Neutral for Direct-Current Three-Wire Systems. James R. Werth, Jr. Read before the N. E. L. A. Compares the types of generating apparatus with particular reference to the method of deriving and controlling the neutral. 2500 w. Elec Age—June, 1910. No. 15108.

D. C. Turbo-Generators.

Direct-Current Turbo-Generators. W. L. Waters. From a paper before the Nat. Elec. Lgt. Assn. Considers factors in the design, and the constructions found satisfactory, referring to foreign practice. 2500 w. Eng News—June 9, 1910. No. 14605.

Induction Motors.

The Right Type of Induction Motor. R. H. Fenkhausen. Describes various types and their operating characteristics. Ills. 2000 w. Power—June 28, 1910. No. 15253.

Notes on the Operation and Testing of Polyphase Induction Motors. J. W. Rogers. 1500 w. Prac Engr—June 10, 1910. Serial. 1st part. No. 15033 A.

The Theory of the Single-Phase Induction Motor (Theorie des Einphasen-Induktionsmotors). Fredrich Schmidt. A brief statement of the theory. Ills. 1200 w. Elektrotech u Maschinenbau—May 8, 1910. No. 15066 D.

Vector Diagrams.

A New Method of Representing Power and Energy in Vector Diagrams (Eine neue Darstellung von Leistung und Energie im Vektordiagramm). Franklin Punga. Mathematical demonstration. Ills. Serial. 1st part. 2500 w. Elektrotech u Maschinenbau—May 15, 1910. No. 15068 D.

Voltage Regulation.

The Voltage Control of Generators and Feeder Systems. F. W. Shackelford. Read before the N. E. L. A. Discusses only alternating-current systems, describing various regulators as applied to different systems. Ills. 3800 w. Elec Age—June, 1910. No. 15197.

Windings.

Winding of Dynamo-Electric Machines. I. Introductory. R. A. Smart. Considers the difference between a. c. and d. c. windings. II. Small Direct-Current Machines. G. I. Stadeker. Considers the threaded-in-from-the-reel type of winding. Ills. 4000 w. Elec Jour—June, 1910. No. 14771.

The Tractive Force Between Current-Carrying Wires and Coils (Ueber die mechanische Kraftwirkung zwischen stromdurchflossenen Leitern und Spulen). R. Czepek. Develops formulae for circular, square and rectangular coils and gives results of tests. Ills. 5000 w. Elektrotech u Maschinenbau—May 8, 1910. No. 15067 D.

ELECTRO-CHEMISTRY.

Electric Furnaces.

The Design of Furnace Electrodes. Carl Hering. Simple rules for proportioning the electrodes for minimum loss. Also editorial note. 3500 w. Elec Wld—June 16, 1910. No. 14798.

A New Resistor Furnace. F. A. J. Fitz-Gerald. Illustrated description of a furnace heated by radiation from resistance. 500 w. Met & Chem Engng—June, 1910. No. 14633 C.

Electrochemical Society.

Pittsburgh Meeting of the American Electrochemical Society. Report of meeting, giving abstracts of papers read. 24000 w. Met & Chem Engng—June, 1910. No. 14636 C.

Electroplating.

An Electroplating Outfit. A. J. Jarman. Description, with practical working formulae. 2000 w. Sci Am—June 25, 1910. No. 15143.

Electrodeposition of Lead from Perchlorate Baths. Frank C. Mathers. Abstract of a paper before the Am. Elec.-Chem. Soc. Describes experiments with the lead perchlorate plating and refining bath. 1800 w. Brass Wld—June, 1910. No. 14721.

Nitrates.

Electrochemical Manufacture of Nitric Acid and Nitrates (La Fabrication de l'Acide nitrique et des Nitrates par l'Electrochimie). Th. Schlœsing. Describes the Birkeland and Eyde plant and process at Notodden, Norway. Ills. 6000 w. Tech Mod—May, 1910. No. 14826 D.

Review of 1909.

Progress in Electrochemistry in 1909 (Fortschritte der Elektrochemie im letzten Jahre). A review of electrochemical patents and literature. Serial. 1st part. 3300 w. Elektrochem Zeitschr—May, 1910. No. 14855 D.

ELECTRO-PHYSICS.

Arcs.

Relation Between Temperature of Electrodes and Voltage of the Electric Arc. C. D. Child. Abstract of an article in the *Phys. Rev.* A résumé of experimental researches which show that the cooling of a carbon arc raises the pressure several volts. 2200 w. Elect'n, Lond—June 3, 1910. No. 14734 A.

Electrostatic Experiments.

Electrification of Insulating Materials. W. Jamieson. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Brief account of investigations of the best kind of materials to use for producing electrification in a humid atmosphere. Short discussion. 1500 w. Elect'n, Lond—May 20, 1910. No. 14448 A.

Hysteresis.

Magnetic Hysteresis in a Rotating Field. M. G. Lloyd. Reviews information obtained by research in regard to rotary hysteresis. 1500 w. Elec Rev, N. Y—June 4, 1910. No. 14581.

Spark Gap.

Spark-Gap Phenomena. J. M'Whan. Abstract of paper read before the Roy. Soc. of Edinburgh. Describes phenomena observed in connection with a solid dielectric placed between the terminals of an induction coil or influence machine. 1700 w. Elect'n, Lond—May 20, 1910. No. 14451 A.

Thermo-Electric Properties.

The Thermo-Electric Properties of Alloys (Sur les Propriétés Thermo-électrique des Alliages). Witold Broniewski. A review of the progress of knowledge in this field, with bibliography. Ills. 7500 w. Rev de Métal—May, 1910. No. 14814 E + F.

GENERATING STATIONS.

Accumulators.

See Isolated Plants, under GENERATING STATIONS.

Central Stations.

The Generating System of an Electric Lighting Company. A. R. Cheyney. Considers briefly the important functions relating to the production of electricity. 8500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14956 F.

Some Developments in Modern Lighting Systems. C. W. Stone. A brief review of modern developments that have changed the character of lighting stations. 4000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14952 F.

Southern California Developments. Del Reynolds. An illustrated account of the work undertaken by Huntington interests to give light, heat, power and transportation to Southern California. 2200 w. Pro Age—June 15, 1910. No. 14763.

Steam-Driven Transmission System. Illustrated description of plant for the supply of cheap electrical energy to mines in the Wisconsin zinc district. 4000 w. Elec Wld—June 16, 1910. No. 14795.

The Greenock Electricity Undertaking. Illustrated description of new works at Dellingburn Street, which combine a generating station and refuse destructor. 2500 w. Elec Rev, Lond—June 10, 1910. No. 15014 A.

A London Electric Supply Station. Illustrated detailed description of the features of interest in the new station in Horseferryroad. The ground floor serves as a power station and an upper story as a sub-station. 2500 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14624 A.

New Generating Station of the Westminster Electric Supply Corporation. Plans and description of the station and its equipment. 2000 w. Elect'n, Lond—May 20, 1910. Serial. 1st part. No. 14447 A.

Marseilles' New Power Plant. Dr. Alfred Gradenwitz. Illustrated description of a recent installation having a capacity of 14000 kilowatts. 2000 w. Power—June 7, 1910. No. 14597.

See also Gas Engines, under MECHANICAL ENGINEERING, Combustion Motors.

Costs.

Operating Costs of Large Units. Information concerning the operating costs of the Commonwealth Edison Company's large turbine units in Chicago. Ills. 3000 w. Power—May 31, 1910. No. 14420.

Economics.

See Incandescent Lamps, under Lighting; and Electric, under MECHANICAL ENGINEERING, Automobiles.

Germany.

The Economic Importance of the Electricity Supply Industry in Germany (Die wirtschaftliche Bedeutung der offentlichen Elektrizitatswerke Deutschlands). G. Dettmar. Gives elaborate statistics of the industry. Ills. 3000 w. Elek Kraft u Bahnen—May 14, 1910. No. 15060 D.

Hydro-Electric.

A General Review of Hydroelectric Engineering Practice. Frank Koester. This fourth article of a series deals with generators, switchboards and electrical equipment. Ills. 3000 w. Engineering Magazine—July, 1910. No. 15250 B.

The Proposed Hydro-Electric Development at Coon Creek Rapids. A. C. Ringsred. An account of a proposed development on the upper Mississippi River. 2500 w. Minn Engr—May, 1910. No. 14765 C.

Housatonic River Hydroelectric Plants. J. Franz. Brief illustrated description of examples of early and modern methods of hydroelectric development. 1200 w. Elec Wld—June 2, 1910. No. 14500.

The McCall Ferry Hydro-Electric Plant on the Susquehanna River. Illustrated detailed description of the design and method of construction of a 135,000 horsepower station. 6000 w. Eng Rec—May 28, 1910. No. 14413.

The Hydroelectric Development of the Great Western Power Company. Illustrated detailed description of the design of this great scheme in California for furnishing power to Oroville, Marysville, Sacramento, Antioch, Oakland and intermediate towns. 3000 w. Eng Rec—June 11, 1910. Serial. 1st part. No. 14686.

Hydroelectric Development on the Niobrara River. W. K. Palmer. Illustrated description of a station near Valentine, Neb., for supplying energy to a projected 128-mile single-phase railway. 2500 w. Elec Wld—June 2, 1910. No. 14501.

Colorado Hydroelectric Installation. Illustrated description of the Glenwood generating station of the Central Colorado Power Co. 1700 w. Elec Wld—June 23, 1910. No. 15137.

Glenwood Hydroelectric Plant, Central Colorado Power Company. Illustrates and describes the hydraulic features of the first plant of an extensive system at Shoshone, near Glenwood. 4000 w. Eng Rec—June 25, 1910. No. 15205.

The Andelsbuch Hydro-Electric Plant near Bregenz (L'Usine hydro-électrique d'Andelsbuch prés de Bregenz). A. Bidault des chaumes. Illustrated description of this plant in the Tyrol. 2200 w. Génie Civil—May 7, 1910. No. 14834 D.

The Electrical Works of the Società Industriale Elettrica della Valnerina, Terni, Italy (Die Kraftübertragungsanlagen der Società Industriale Elettrica della Valnerina in Terni, Italien). L. Pasching. Illustrated description of the "La Cervara" power station. 4000 w. Elek Kraft u Bahnen—May 14, 1910. No. 15061 D.

See also Water Powers, under CIVIL ENGINEERING, Waterways and Harbors.

Isolated Plants.

Isolated Plants and Central Station Current. E. Coleman Fay. Remarks on factors that must be considered, cost, reliability, etc. 1500 w. Eng Rec—June 18, 1910. No. 14998.

Investigations of Energy Supply for a Group of Manufacturers. Analysis of supply for a building containing 19 tenants manufacturing various commodities.

1800 w. Elec Wld—June 16, 1910. No. 14790.

Economical Small Electric Plants. Warren H. Miller. Illustrates and describes small plants in Europe showing remarkable engine economy. 2000 w. Elec Wld —June 2, 1910. No. 14502.

Electricity in Leather Manufacturing. Fred S. Sly. Illustrated description of the new power plant of the Pfister & Vogel Leather Co., Milwaukee, Wis. 2000 w. Elec Rev, N Y—June 18, 1910. No. 14989.

Operation of the Coast Artillery School Power Plant. Offnere Hope. Reports plant tests and analysis, and the operation, economy, etc. Ills. 7500 w. Jour U S Art—May-June, 1910. No. 14764 D.

A Palatial Steam Power Plant. A. R. Maujer. Illustrated description of the mechanical plant for furnishing heat, light, elevator service, etc., in Charles Schwab's New York residence. 1500 w. Power—June 28, 1910. No. 15250.

A Storage-Battery Extension to a Three-Phase Colliery Power-Plant. William Maurice. From a paper read before the Inst. of Min. Engrs. Explains the situation that demanded a supply of more power and how it was met. Ills. 1400 w. Col Guard—June 3, 1910. No. 14745 A.

Reliability.

Continuity of Supply in Modern Power Stations. H. I. Liwenz. Discusses the plant arrangement necessary to secure unbroken continuity of supply. 4500 w. Engr, Lond—May 20, 1910. No. 14476 A.

Switchboards.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

Switchgear.

High-Tension Switchgear. A. G. Collis. Discusses recent practice in switchgear design and illustrates typical installations. 3500 w. Elect'n, Lond—June 3, 1910. No. 14735 A.

The Modern Oil Switch With Special Reference to Systems of Moderate Voltage and Large Ampere Capacity. A. R. Cheyney. Considers the type used in the large generating systems of cities, and also switchboard construction. 7500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14960 F.

LIGHTING.

Illumination.

The Physical Production of Light. Edw. P. Hyde. A study of certain questions in physiological optics, discussing the laws of radiation and the radiating properties of metals. 8000 w. Jour Fr Inst—June, 1910. Serial. 1st part. No. 14921 D.

The Calculation of Illumination. C. Toone. States assumptions and explains method. 1500 w. Elec Rev, Lond—June 10, 1910. No. 15015 A.

Regulation and Illumination. L. B. Spinney. Read before the Iowa Elec. Assn. Gives tables and illumination curves showing the importance of good regulation. 2500 w. Elec Rev, N Y—June 4, 1910. No. 14582.

The Illumination of Very Large, High Rooms. Jas. R. Cravath. Illustrated description of the lighting equipment of a large track room and gymnasium. 2200 w. Elec Wld—June 23, 1910. No. 15141.

Incandescent Lamps.

Radiation from Metals. Edward P. Hyde. Abstract of paper before the Am. Phys. Soc. Discussion of investigations relating to the selection of metallic filament lamps. 2500 w. Elec Wld—June 23, 1910. No. 15139.

High Efficiency Lamps, Their Effect on the Cost of Light to the Central Station. S. E. Doane. Read before the N. E. L. A. Convention. Gives results of experience, observation, and analysis. 4800 w. Cent Sta—June, 1910. No. 14962.

Metal Filament Lamps. John W. Howell. Mainly a discussion of tungsten lamps and their advantages and the importance of lamp testing. 3000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14951 F.

A New Form of Tungsten Lamp. Charles F. Scott. From a paper read before the Nat. Elec. Lgt. Assn. Illustrated description of the "wire type" developed by the Westinghouse Lamp Co. 2500 w. Elec Jour—June, 1910. No. 14772.

See also Tungsten, under MECHANICAL ENGINEERING, Materials of Construction.

Lighthouses.

See same title, under CIVIL ENGINEERING, Waterways and Harbors.

Photometry.

Some Methods of Measuring Light. W. C. Philpott. Read before the Can. Gas Assn. Illustrated review of methods used and tests made. 2800 w. Am Gas Lgt Jour—June 27, 1910. No. 15213.

Searchlights.

Searchlight Projectors for Marine Purposes. E. A. Holmes. Illustrates and describes the type used and some special accessories. 1500 w. Elect'n, Lond—June 10, 1910. No. 15027 A.

Electric Military Searchlights (Les Projecteurs électriques Militaires). A. Bochet. A review of their development, describing modern types. Ills. 8000 w. Bul Soc Int d Elecns—May, 1910. No. 14808 F.

Street.

Factors That Should Be Considered in Making Street Lighting Contracts. S. M. Rust. Read before the Ohio Elec. Lgt. Assn. Discusses some of the more important factors. 1800 w. Munic Engng—June, 1910. No. 14925 C.

A High Efficiency Reflector for Street Lighting. Clayton H. Sharp. Abstract of a paper before the Ill. Engng. Soc. Illustrated description of a new form designed to give a more uniform illumination. 2500 w. Elect'n, Lond—June 17, 1910. No. 15228 A.

MEASUREMENT.

Dynamo Testing.

The Determination of the Efficiency of Direct-Current Machines by the Hopkinson Test. C. V. Drysdale. Describes a simple method of carrying out the test. 1200 w. Elect'n, Lond—June 3, 1910. No. 14733 A.

Galvanometers.

The Einthoven Galvanometer (Le Galvanomètre Einthoven). H. Marchand. Description of a special type of galvanometer developed for the study of high-frequency currents. Ills. 1000 w. L'Elecn—May 21, 1910. No. 14822 D.

Oscillographs.

Determination of the Power of Alternating Currents from Oscillographs (Effektbestimmung von Wechselströmen aus Oszillogrammen). E. Behne. Mathematical demonstration of a simple graphical method. Ills. 1200 w. Elektrotech u Maschinenbau—May 1, 1910. No. 15065 D.

POWER APPLICATIONS.

Gas Works.

Electricity in French Gas Plant. Warren H. Miller. Illustrates and describes uses of electrical energy in the city of Paris gas works. 2800 w. Elec Wld—June 9, 1910. No. 14657.

Pumping.

See Electric Pumping, under MECHANICAL ENGINEERING, Hydraulic Machinery.

TRANSMISSION.

Alternating Current.

Symbolic Alternating-Current Equations. G. E. Marsh. A review of the general equations for expressing relations in a. c. circuits. 800 w. Elec Wld—June 16, 1910. No. 14796.

Application of Symbolic Equations. Harry P. Wood. The solution of problems involving star-connected three-phase circuits. 500 w. Elec Wld—June 16, 1910. No. 14797.

Earthing.

Earth Currents and Their Influence on Earthing (Ueber Erdströme und ihre Einflüsse auf die Erdung). E. Rühle. Discusses the best method of making earth connections. Ills. 2000 w. Elek Kraft u Bahnen—May 4, 1910. No. 15058 D.

Fault Location.

Localization of Faults on Underground Mains. W. A. Toppin. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Gives the results of the author's experience with a 3-wire direct-current system, describing a simple method of locating earth leakages without interrupting the supply. 2000 w. Mech Engr—May 20, 1910. No. 14462 A.

Insulators.

The Application of Porcelain to Strain Insulators. W. H. Kempton. Considers the advantages and disadvantages of porcelain for insulators, and reports tests made to secure data for use in insulator design. Discusses features of the design. Ills. 1800 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14953 F.

Lightning.

Atmospheric Electricity. Elihu Thomson. Abstract of an address at the formal opening of the Palmer Physical Laboratory, at Princeton University. A review of present knowledge on this subject. Ills. 5500 w. Sci Am Sup—June 18, 1910. No. 14915.

Lightning Protection.

Practical Means of Protecting the Insulators of High-Tension Lines Against Lightning and Excess Voltages (Praktische Massnahmen zum Schutze der Isolatoren von Hochspannungsleitungen gegen Blitzschlag und Starkstromübergang). W. Weicker. Describes various types of insulator design. Ills. 2300 w. Elek Kraft u Bahnen—May 24, 1910. No. 15063 D.

Line Construction.

Transmission Line Crossings of Railroad Rights-of-Way. Allen H. Babcock. Gives general specifications covering the points under discussion between the power and railroad companies. 1500 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14955 F.

Transmission-Line Crossings Over Railways. From the joint report of the Committee on Overhead Line Construction of the Nat. Elec. Lgt. Assn., and the Committee on Electricity of Am. Ry. Engng & Main. of Way Assn. 3000 w. Eng News—June 9, 1910. No. 14664.

Line Design.

Transmission Line Equations. C. P. Steinmetz. Derives the equations directly from line constants and discusses their accuracy. 700 w. Elec Wld—June 23, 1910. No. 15138.

Some Problems in Power Transmission. H. W. Buck. Read before the N.-E. L. A. Discusses towers, spans, insulators, conductors, voltage, regulation, frequency, etc. 2500 w. Elec Age—June, 1910. No. 15196.

Problems in Power Transmission. H. W. Buck. Abstract of paper read before the Nat. Elec. Lgt. Assn. Discusses the introduction of steel towers, the lengthening of the space, installation of conductors, voltage and its regulation, etc. 2500 w. Eng News—June 23, 1910. No. 15131.

New Ideas in Electrical Distribution Methods. S. B. Way. Read before the Nat. Elec. Lgt. Assn. Describes new ideas in construction and operation in St. Louis and vicinity. 2000 w. Eng News—June 9, 1910. No. 14663.

Live-Wire Indicators.

A New High-Tension Indicator (Ein neuer Hochspannungsanzeiger). Hermann Zipp. Describes a portable device for detecting live wires, for the use of linemen. Ills. 2000 w. Elek Kraft u Bahnen—May 4, 1910. No. 15059 D.

Poles.

Reinforced Concrete Poles. Data and descriptions of different types of construction, taken from a paper prepared by Messrs. R. D. Coombs and C. L. Slocum. 2500 w. Eng Rec—June 18, 1910. No. 14997.

Transformers.

Modern Problems of Transformer Design. Louis F. Blume. Considers capacity, artificial cooling, materials used, etc. Ills. 2500 w. Sib Jour of Engng—June, 1910. No. 14932 C.

MISCELLANY.

Accidents.

Accidents Caused by Electrical Currents (Les Accidents causés par le Courant électrique). M. d'Arsonval. Discusses the effects of electric shocks, treatment, first-aid, tests to determine death, etc. 3800 w. Bul Soc Int d'Elecns—May, 1910. No. 14809 F.

Agriculture.

Electricity and Plant Growth (Versuche über Elektrokultur). Dr. Gerlach and Dr. Erlwein. A report of recent tests in Germany. Ills. Serial. 1st part. 1500 w. Elektrochem Zeitschr—May, 1910. No. 14854 D.

Austria.

The Austrian Electrical Industry in 1909 (Die elektrotechnische Industrie im Jahre 1909). Emil Honigmann. The first part discusses the slow development of the electrical industries in Austria and Hungary. Serial. 1st part. 3000 w. Elektrotech u Maschinenbau—May 22, 1910. No. 15069 D.

INDUSTRIAL ECONOMY.

Cost Systems.

Cost Accounting in Manufacturing (De Verrekening der "onkosten" in het Fabrieksbedrijf). K. G. Simon. A discussion of the principles and practice of cost determination. Ills. 8500 w. De Ingenieur —May 14, 1910. No. 15082 D.

Education.

Suggestions for the Education of a Civil Engineer. H. M. North. Discusses the aims and suggests some methods of attaining them. 4800 w. Wis Engr—June, 1910. No. 14927 D.

The Education of Mechanical Engineers (Ueber die Heranbildung der Ingenieure in mechanischen Betrieben). Johann Ritter v. Merkl. A discussion of conditions in Austria. 3500 w. Zeitschr d Oest Ing u Arch Ver—May 20, 1910. No. 14895 D.

Report of Committee on Industrial Education. P. Kreuzpointner. 4000 w. Am Found Assn—June, 1910. No. 15105 N.

The Training of Men—A Necessary Part of the Modern Factory System. Discussion of Magnus W. Alexander's paper on this subject. 5000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14949 F.

The Working of the Educational Bureau of the Union Pacific. Explains what this bureau is doing and how it is doing it. 5500 w. Ry Age Gaz—June 10, 1910. No. 14683.

Engineering English.

Standardization of English in Technical Literature. T. A. Rickard. A critical review of words improperly used. 7000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14919 N.

Exhibitions.

The Brussels International Exhibition. Describes a number of the displays, including boiler accessories and fittings; heating and ventilating plants; agricultural and laundry machinery. 5000 w. Engng—June 3, 1910. Serial. 1st part. No. 14753 A.

Management.

The Twelve Principles of Efficiency. Harrington Emerson. This second article of a series shows by natural analogy, and contrast wherein efficiency organization differs from the old military type. 5500 w. Engineering Magazine—July, 1910. No. 15258 B.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. This third article of a series discusses simple methods for keeping down shop expenses. 2500 w. Engineering Magazine—July, 1910. No. 15262 B.

Scientific Factory Management. Holden A. Evans. Explains the aims of scientific management. 4500 w. Am Mach—Vol. 33. No. 24. No. 14791.

How the Foreman Can Promote Shop Efficiency. C. J. Drury. An article submitted in a prize competition. Also articles by E. T. Spidy and by Elmo N. Owen. 4000 w. Ry Age Gaz—June 3, 1910. No. 14542.

Patents.

Licenses to Work Patents. Remarks on English patent laws, especially explaining licenses to manufacture. 2200 w. Engr, Lond—June 17, 1910. No. 15237 A.

Prices.

The Cost of Living; Has It Risen, and Why? Alex. Del Mar. Discusses alleged and real causes and their proportionate effects. 4500 w. Engineering Magazine—July, 1910. No. 15264 B.

Publicity.

Publicity and French Industry (La Publicité et l'Industrie française). Octave Jacques Gérin. A discussion of the function of publicity in industry and the best means of promoting it. Ills. 8000 w. Bul Soc d Encour—April, 1910. No. 14817 G.

Purchasing.

Organization of a Purchasing Department on Railroad Systems. Edward Norton Chilson. Aims to cover the important points with regard to the duties of the purchasing department and the methods of maintaining an efficient system. 4000 w. Jour of Acc—June, 1910. No. 14648 C.

Wage Systems.

The Law of December 7, 1909, Governing the Payment of Wages (La Loi du 7 Décembre 1909 sur le Payement des Salaires des Ouvriers et Employés). Maurice Bellom. A criticism of recent legislation in France. 2600 w. Génie Civil—May 21, 1910. No. 14842 D.

MARINE AND NAVAL ENGINEERING.

Barges.

Steel Barges for the Mississippi. Plan, section, and description of a type to be built for the transportation of steel products. 1000 w. Ir Age—June 9, 1910. No. 14653.

Reinforced Concrete Barges on the Pacific Division of the Panama Canal. Gives reasons for the use of reinforced concrete, and illustrates and describes the barges. 2000 w. Eng Rec—May 28, 1910. No. 14419.

Battleships.

Forty Years' Progress in the Displacement and Speed of Warships. Gives a list of representative British vessels of battleship and cruiser types for the last forty years, with the speed coefficient and h. p. per ton of displacement of each, discussing developments. 2000 w. Engr, Lond—June 3, 1910. No. 14757 A.

Increase in Displacement of Battleships since the Appearance of the Armored Cruiser (Deplacementssteigerungen der Linienschiffe seit Erscheinen der Hochseepanzerschiffe). Franz Eissenhardt. A review of recent tendencies in battleship design. 2500 w. Schiffbau—May 11, 1910. No. 14876 D.

The New Russian Battleships. Elevation and plans, with critical discussion of the designs. 2500 w. Engng—May 20, 1910. No. 14471 A.

Trials of the Brazilian Battleship "Sao Paulo." Report of trials, with illustration and information. 2500 w. Engng—June 3, 1910. No. 14754 A.

Compasses.

Compass Deviations. William C. Ward. Considers the behavior of the compass on iron and steel ships. 2000 w. Sci Am Sup—June 4, 1910. No. 14506.

Cruisers.

The Comparative Trials of the American Scouts. Reviews the recent report of the U. S. Navy Department on the trials of the Birmingham, Salem, and Chester. 1800 w. Engr, Lond—June 3, 1910. No. 14755 A.

The Brazilian Scout Cruisers. Illustrated detailed description of the Bahia and the Rio Grande do Sul, and their equipment. 3000 w. Engr, Lond—May 20, 1910. No. 14477 A.

Destroyers.

The Destroyer—Our Naval Weakness. Yates Stirling, Jr. Gives a brief sketch of the development of these vessels, and presents arguments to prove them necessary as a part of a fighting fleet. 4000 w. Pro U S Naval Inst—June, 1910. No. 15101 F.

The French Destroyer Voltigeur. Illustrated article giving information concerning the vessel and its equipment, and report of official trials. 2000 w. Engr, Lond—June 3, 1910. No. 14756 A.

Dredges.

Light-Draft Stern-Wheel Suction Dredge for Navigation Improvement on the Niger. States the requirements and gives an illustrated description of the vessel designed for the work. 1500 w. Eng News—June 16, 1910. No. 14905.

A Light-Draught Sand-Pump Dredger. Illustrated description of a dredger recently built for the improvement of the river Niger, explaining the conditions to be fulfilled. 1500 w. Engr, Lond—May 20, 1910. No. 14479 A.

Electric Power.

The Evolution of Electrical Engineering in the Navy. Discusses progress and describes the general layout of the electrical equipment. 4500 w. Elect'n, Lond—June 10, 1910. No. 15017 A.

The Future of Electricity on Ships. A. P. Chalkley. Shows a promising outlook, the tendencies being either to use it for all purposes, or to apply it to every purpose except propulsion. 3000 w. Elect'n, Lond—June 10, 1910. No. 15016 A.

Marine Propulsion by Electric Motors. Henry A. Mavor. Investigates a special case where the present method of driving is admittedly efficient and cheap, and discusses the subject generally. 3000 w. Elect'n, Lond—June 10, 1910. No. 15018A.

A System of Turbo-Electric Propulsion of Ships. H. C. Leake. Describes a system using ordinary three-phase generators and squirrel-cage motors. 3000 w. Elect'n, Lond—June 10, 1910. No. 15019 A.

Electrical Marine Propulsion on the "Paragon" System. Wiliam P. Durtnall. Considers two cases in detail in which the effect is estimated of replacing the usual steam drive by the "Paragon" electric system. Ills. 5000 w. Elect'n, Lond—June 10, 1910. No. 15020 A.

Electro-Mechanical Propulsion with Diesel Engines. W. P. Sillince. Gives figures on the economy of the Diesel oil engine, and outlines the Mirrles system of electro-mechanical propulsion. Ills. 1200 w. Elect'n, Lond—June 10, 1910. No. 15021 A.

The Use of Electrical Power for Auxiliary Purposes on Board Ship. James A. Seager. Discusses the causes that are unfavorable to its adoption, and considers examples in use. 3500 w. Elect'n, Lond—June 10, 1910. No. 15030 A.

Switchboards on Warships. A. G. Collies. Summarizes former and present specifications and criticises the lack of uniformity in design. 2500 w. Elect'n, Lond—June 10, 1910. No. 15023 A.

Recent D. C. Turbogenerators with Special Reference to their Application on Shipboard (Neuere Gleichstrom-Turbogeneratoren mit besonderer Berücksichtigung ihrer Anwendung auf Schiffen). Fr. Heintzenberg. Discusses their application to ship propulsion and for lighting and power. Ills. 3200 w. Schiffbau—May 25, 1910. No. 14877 D.

See also Steering Gears, under MARINE AND NAVAL ENGINEERING.

Electric Wiring.

The Wiring of Ships. G. Austin. Discusses the question of the most suitable voltage, and the various systems of wiring that may be used. 6000 w. Elect'n, Lond—June 10, 1910. No. 15024 A.

Fireboats.

A New Fireboat for Seattle, Wash. M. H. Strouse. Illustrated detailed description of the "Duwamish," a powerful fireboat. 1800 w. Eng News—June 23, 1910. No. 15130.

Fire Boats David Scannel and Dennis T. Sullivan for San Francisco Harbor. Illustrated detailed description of these boats. 4000 w. Int Marine Engng—June, 1910. No. 14524 C.

The New Boston Fire Boat Engine 47. Illustrated description of one of the fiastest, most powerful and efficient vessels ever built for fire service in America. 1000 w. Int Marine Engng—June, 1910. No. 14525 C.

Gun Turrets.

The Cutler-Hammer Manufacturing Company's Differential System of Turret Training Gear. W. H. G. Bullard. Gives a general description of this method of turret turning, explaining the principle and operation. Ills. 4500 w. Pro U S Naval Inst—15104 F.

Motor Boats.

Techincal Aspects of the 1910 Monaco Meeting (Technisches vom Monaco-Meeting 1910). Conrad Harmsen. Ills. Serial. 1st part. 2000 w. Motorwagen—May 10, 1910. No. 14888 D.

Oil Fuel.

Fuel-Oil Installation and Tests Made on U. S. S. Chayenne. F. F. Ingram. Describes the installation and reports tests. 6800 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15093 H.

First Oil-Burning Turbine Steamers. Warren O. Rogers. Illustrated description of the oil burning equipment recently installed in steamships Yale and Harvard of the Metropolitan line, New York City. 1200 w. Power—June 21, 1910. No. 15010.

Propellants.

Nitro-Cellulose Powder for Naval Purposes. Editorial discussion of the French Service explosive compound, believing it to be quite unsuitable for naval purposes, and referring to a recent article in the *Memorial des Powdres et Saltpetres*. 3000 w. Engng—May 20, 1910. No. 14470 A.

Shipbuilding.

Mitsu-Bishi Dockyard and Engine Works. An illustrated review of the history and a description of the shipbuilding and engineering works. 7000 w. Engng—May 20, 1910. No. 14472 A.

Ship Cleaning.

Removing Scale from Hulls of Ships with Pneumatic Hammers Under the Piece-Work System. Illustrates and describes tools used and methods adopted, giving results obtained. 2000 w. Marine Rev—June, 1910. No. 14970.

Corrugated Sides of S. S. "Monitoria" and Their Effect. A. H. Haver. Claims advantages in seakindliness, speed and carrying capacity. Description. Plates. General discussion. 17500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1910. No. 15144 N.

Ship Illumination.

Ship Illumination and Fittings. G. Austin. Discusses the character of illumination and fittings for various uses. Ills. 3000 w. Elect'n, Lond—June 10, 1910. No. 15026 A.

Ships' Diameter.

A New Method for Determining the Final Diameter of a Ship. D. W. Taylor. Explains a simple method of determining the final diameter in making turning trials. 700 w. Pro U S Naval Inst—June, 1910. No. 15102 F.

Ships' Telephones.

Ships' Telephones. H. S. Thompson. Illustrates and describes the general scheme adopted on board a ship, the instruments, and other details. 4000 w. Elect'n, Lond—June 10, 1910. No. 15028 A.

Steam Boilers.

A Japanese Watertube Boiler. The Miyabara watertube boiler widely used for marine and stationary work in Japan. It was installed on a number of warships that saw service in the Russo-Japanese war, and proved to be the only type which could be kept under steam for six months without cleaning. Ills. 1000 w. Boiler Maker—June, 1910. No. 15120.

Test of Thornycroft Boilers, Fuel-Oil Apparatus, and Fire-Room Fans on Torpedo-Boat Destroyer "Roe." C. F. Bailey. Illustrates and describes tests which indicate that the installation will prove economical. 1200 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15091 H.

Steam Engines.

The Latest Marine Engine Proposition. A. B. Willits. Gives a brief résumé of previous developments, and notes on a new and remarkable roto-turbo combination devised by Gerard P. Herrick. Ills. 5500 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15090 H.

See also Engine Testing, under MARINE AND NAVAL ENGINEERING.

Steamships.

The North Land. Illustrated description of a vessel for service between New York and Portland, Me. 1800 w. Int Marine Engng—June, 1910. No. 14521 C.

The Grand Trunk Pacific Company's T.-S.S. "Prince Rupert." Illustrated detailed description of steamers for service on the Pacific coast. Plates. 2500 w. Engng—June 17, 1910. No. 15235 A.

Bulk-Oil Steamship J. A. Chanslor. Illustrated detailed description of the vessel and its equipment. 2500 w. Int Marine Engng—June, 1910. No. 14520 C.

A New Type of Iron Ore Transport. F. C. Coleman. The "Vollrath Tham," built to the British Corporation highest class, is illustrated and described. 1500 w. Int Marine Engng—June, 1910. No. 14523 C.

Steam Turbines.

Coal Consumption of French Torpedo-Boat Destroyers with Turbines, Reciprocating Engines and Combination Machinery. Ernest N. Janson. Gives results obtained with three destroyers of the French Navy in recent official trials. Ills. 3500 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15089 H.

Impulse and Reaction Marine Steam Turbines. Sir William H. White. A criticism of previous estimates of the relative merits of German, American, and Parsons types of turbines, reviewing statements in a recently published article on "Impulse Turbines in Germany." 4000 w. Engr, Lond—May 27, 1910. No. 14622 A.

Steering Gears.

Electric Steering Gear. A. P. Chalkley. Illustrates and describes a number of systems. 3000 w. Elect'n, Lond—June 10, 1910. No. 15025 A.

Submersibles.

Submersible. Robert G. Skerrett. Explains the distinction between submarines and submersibles, considers types, factor of displacement, seaworthiness, form of hull, buoyancy, speed, etc. Ills. 11000 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15092 H.

The Norwegian Submersible Kobben. Illustrates and describes the vessel and reports trials. 800 w. Engr, Lond—June 17, 1910. No. 15242 A.

Tugs.

A Powerful Stern Wheel Towboat. Profile, cross section and description of the improved type vessel "Gamecock," designed for heavy towing. 1200 w. Int Marine Engng—June, 1910. No. 14522 C.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Acceleration.

Tractive Efforts and Acceleration of Automobile Vehicles on Land, Air, and Water. F. W. Lanchester. Read before the Inst. of Mech Engrs. Discusses neglected aspects of the subject, explaining the method employed by the author for the measurement of acceleration and tractive effort, and showing the uses of acceleration diagrams. 1500 w. Auto Jour—May 2, 1910. Serial. 1st part. No. 14443 A.

Agricultural.

Automobiles in Agriculture (Coltivazione del Suolo mediante Veicoli automotori). S Herzog. Describes a number of "Konig" automobile vehicles and machines. Ills 3000 w. Industria—May 22, 1910. No. 14848 D.

Bodies.

When a New Body Must be Purchased. Illustrated discussion of characteristics of body types. 1800 w. Automobile—May 26, 1910. Serial. 1st part. No. 14410.

Carburation.

An Analysis of Carburation Troubles. Albert L. Clough. Discusses especially difficulties in carburation due to impurities in the fuel and difficulties arising from differences in the volatility of the fuel. 2500 w. Horseless Age—June 25, 1910. No. 15212.

Carburettors.

An Investigation of Recent Carburettors (Studie über neuere Vergaser). F. Ernstes. Describes and discusses recent types. Ills. Serial. 1st part. 3200 w. Zeitschr d Mit Motorwagen Ver—May 31, 1910. No. 14886 D.

Commercial Vehicles.

Interesting New Commercial Vehicle Models. Illustrates and describes new models. 4000 w. Com Veh—June, 1910. No. 14500 C.

Notes on Gas-Motor Commercial Vehicle Design. T. B. Browne. Read before the Inst. of Auto. Engrs., London. Suggestions for successful designs. Ills. 2500 w. Com Veh—June, 1910. Serial. 1st part. No. 14508 C.

Daimler.

The 15-H. P. Daimler Chassis. Illustrated description. 800 w. Auto Jour—May 21, 1910. No. 14442 A.

Electric.

The Electric Vehicle Opportunity. Hayden Eames. Read before the N. E. L. A. Convention. Discusses the growing use of electric vehicles and its effect on central stations. 3300 w. Cent Sta—June, 1910. No. 14963.

Electric Batteries.

New Edison Storage Battery. Joseph B. Baker. Illustrates and describes the nickel iron battery, and its charging. 1500 w. Horseless Age—June 15, 1910. No. 14981.

Charging Ignition Batteries in Conjunction With Vehicle Batteries. Albert L. Clough. 800 w. Horseless Age—June 15, 1910. No. 14982.

How to Handle Ignition and Lighting Storage Batteries. Illustrated explanation of the general characteristics, and of the care needed. 3500 w. Horseless Age—June 1, 1910. No. 14554.

Fuel Gauges.

An Invaluable Modern Car Fitment. Drawings and description of the "Handy" fuel gauge, explaining the system. 2500 w. Auto Jour—June 11, 1910. No. 15013 A.

A Solution of the Petrol-Gauge Problem. Illustrated description of the "Handy" type of petrol gauge for use with gravity feed and pressure feed systems. 3000 w. Auto Jour—June 11, 1910. No. 15012 A.

Humber.

The 12-H. P. Humber. Illustrated description of the latest Humber chassis. 800 w. Auto Jour—May 28, 1910. No. 14607 A.

Ignition.

The Eisemann Magneto. Illustrated description of an automatic ignition device. 1200 w. Autocar—June 18, 1910. No. 15225 A.

Bosch Dual Ignition System Explained. Ills. 1000 w. Automobile—June 9, 1910. No. 14674.

Discussing Features of Various Makes of Magnetos. Herbert L. Towle. Ills. 1200 w. Automobile—June 2, 1910. Serial. 1st part. No. 14536.

Industry.

Detroit's Supremacy in Automobiles. Reviews the development of the industry in southeastern Michigan. 3500 w. Ir Trd Rev—June 2, 1910. No. 14507.

Laws.

Automobile Law Chart for States Which Regulate. Xenoption P. Huddy. Gist of the automobile laws of all the states in the Union which regulate the use of automobiles. 500 w. Automobile—June 16, 1910. No. 14966.

Lighting.

A Home-made Generator. J. B. Jolly. Illustrates and describes the generator of the "diving bell" type, designed by the writer. 1600 w. Autocar—June 4, 1910. No. 14726 A.

Maudslay.

The 17-H. P. Maudslay. Illustrates and describes the chassis of this car. 1200 w. Auto Jour—June 18, 1910. No. 15224 A.

Motor Cooling.

Recent Developments in Motor-Cooling Devices (Die Kühlung von Motorfahrzeugen unter besonderer Berücksichtigung neuerer Kühlapparate-Konstruktionen). August Bauschlicher. Illustrates and describes recent developments. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—May 31, 1910. No. 14887 D.

Motors.

Revolving Cylinder Engines. Eric W. Walford. Discusses features of engines of the Gnome type with a view to their adoption for motor car work. Ills. 1600 w. Autocar—June 4, 1910. No. 14727 A.

Valve System and Valve Openings. Eugene P. Batzell. Theoretical investigation of the rate of opening and the duration of opening. Diagrams. 3000 w. Horseless Age—May 25, 1910. Serial. 1st part. No. 14486.

Pugeot.

The Pugeot "Twelve-Fifteen." Illustrated description of a car of the 80 M M. class. 1600 w. Auto Jour—June 18, 1910. No. 15223 A.

Spare-Rim Carrier.

An Admirable Spare-Rim Carrier. Illustrates and describes a Dunlap accessory. 1500 w. Auto Jour—June 4, 1910. No. 14725 A.

Starting.

How About Starting on the Spark? Gives opinions of autoists based on experience tending to show that it is not a dependable way of starting. 3000 w. Automobile—June 2, 1910. No. 14535.

A Foot-Starter for Petrol Cars. Illustrated detailed description of the Duff, Morgan, and Vermont foot-starter. 1500 w. Auto Jour—May 21, 1910. No. 14441 A.

The Doom of the Starting-Handle. Explains the advantages of abolishing the starting-handle in favor of the foot-starter. Ills. 1200 w. Auto Jour—May 21, 1910. No. 14440 A.

Stearns.

Fuel System of Stearns Model 30-60. Facts relating to the gasoline storage and the method of feeding it to the carbureter. Ills. 2500 w. Automobile—June 16, 1910. No. 14965.

Testing.

Automobile Testing Plant of University of Kentucky. Arthur M. Elam. Brief description of a plant for studying problems arising in the operation of automobiles. Also describes a chart for rapidly computing the horse-power. 1200 w. Horseless Age—June 1, 1910. No. 14553.

Wheels.

Road Wheels for Light Tractors. Discusses the requirements of the Heavy Motor Car Act of 1904, in England. 2200 w. Mech Wld—June 3, 1910. Serial. 1st part. No. 14743 A.

COMBUSTION MOTORS.

Gas-Engine Rating.

Rating of Stationary Gas Engines. G. W. Lewis, and A. G. Kessler. Considers the determination of rated brake horsepower, of r. p. m., and of stroke. 800 w. Sib Jour of Engng—June, 1910. No. 14931 C.

Gas Engines.

Gas Engine Development, Construction and Application. R. A. Fraser. Reviews the development, describing the construction, some applications, etc. 4500 w. Can Engr—June 23, 1910. No. 15194.

Notes on Gas Engine Economy. P. F. Walker. Presents data derived from a series of tests made on a 6 x 12-inch engine with "hit-and-miss" governor, using natural gas and a special brake. 2000 w. Power—June 7, 1910. No. 14599.

Gas Engines for Driving Alternating Current Generators. H. G. Reist. Discusses the desirable characteristics. 1100 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14947 F.

Large Gas Engines in Steel Works. Richard Bechtel. From a paper on the Nurnberg Gas Engine, read before the Birmingham Assn. of Mech. Engrs. An illustrated article explaining their advantages in utilizing gas from blast furnaces. 4000 w. Ir Age—June 16, 1910. No. 14903.

Campbell Gas and Oil Engines at the Brussels Exhibition. Illustrated description of the exhibits of this company. 1000 w. Engng—May 27, 1910. No. 14618 A.

Gas Power Plants.

Producer Gas Plants. Short paper on the fundamental principles of such plants, introductory to a discussion of E. M Rhett's paper on this subject. 4000 w. Pro S & S-W Ry Club—May 19, 1910. No. 15254 E.

Operating Experiences with a Blast Furnace Gas Power Plant. Heinrich J. Freyn. Describes experiences and results obtained during regular service. Ills. 21500 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14943 F.

G. M. A. Gas-Power Plants Using Peat as Fuel (Die G. M A.-Torfgasmaschinenanlagen). Describes apparatus for the utilization of peat manufactured in Garlitz, Austria. Ills. 3000 w. Oest Zeitschr f Berg u Huttenwesen—May 28, 1910. No. 14869 D.

Gas Producers.

See Thermodynamic Units, under STEAM ENGINEERING.

HEATING AND COOLING.

Air Liquifaction.

Industrial Oxygen (L'Oxygène industriel). Georges Claude. A review and discussion of commercial processes of production. 5000 w. Rev de Métal—May, 1910. No. 14815 E + F.

Central Plants.

The Heat Supply in Central Heating. Prof. J. D. Hoffman. From a paper read before the Nat'. Dist. Heat. Assn., Toledo. Discusses the volume and effect of exhaust steam in central heating calculations. 2000 w. Met Work—June 4, 1910. No. 14519.

A Central Heating Station. W. A. Wolls. Abstract of a paper read before the Nat'. Dist. Heat. Assn. Gives data of service and cost of heating. 1000 w. Power—June 28, 1910. No. 15251.

Cooling Towers.

The Influence of Atmospheric Conditions on Water-Cooling Plants (Verlauf der Kühlzonen bei Rückkühlanlagen in Abhängigkeit von den atmosphärischen Verhältnissen). Herr Willnecker. A theoretical investigation. Ills. Serial. 1st part. 4000 w. Die Turbine—May 20, 1910. No. 14878 D.

Fan Testing.

Fan Testing at the American Blower Co. Benjamin W. Loye. Briefly discusses the commercial, engineering and scientific tests. 1500 w. Minn Engr—May, 1910. No. 14767 C.

Hot-Water Heating.

Air-Venting Hot-Water Heating Systems. Charles L. Hubbard. Considers piping arrangements for the automatic escape of air, giving details of three methods. Ills. 900 w. Met Work—June 4, 1910. No. 14518.

A Short Method of Designing Hot-Water Heating Systems (Metodo abbreviato di Calcolo di Termosifoni). C. A. Gullino. Discusses the design of natural circulation hot-water heating systems. Ills. 2500 w. Monit Tech—May 10, 1910. No. 14846 D.

Refrigeration.

Ammonia. Waldemar C. Klotz. Explains its nature, origin, manufacture, and important uses. 1600 w. Ice & Refrig—June, 1910. No. 14549 C.

The Westinghouse-Leblanc Refrigerating Machine (Machine frigorifique à Eau, Système Westinghouse-Leblanc). E. Lemaire. Describes in detail the machine and the installation at the Béthune mines. Ills. 4000 w. Génie Civil—May 28, 1910. No. 14843 D.

Steam Heating.

Calculations for Heating a Concrete House. Daniel R. Bacon. Gives methods and formulae used in making the calculations for a heating system of the type described. Ills. 2200 w. Heat & Vent Mag—June, 1910. No. 14923.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Efficiency of Centrifugal Pumps. F. W. Kerns. Gives a method of measuring the efficiency. 700 w. Min & Sci Pr—June 11, 1910. No. 14972.

A New Six-Stage Turbine Pump. Illustrated description of a pump manufactured in Glasgow. 500 w. Engr, Lond—June 17, 1910. No. 15246 A.

Recent Rateau Pump Installations (Rateaupumpen und neuere Anlagen mit Rateaupumpen). Ernst Blau. Describes the pump and applications to water-works service. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—May 6, 1910. No. 14894 D.

Electric Pumping.

Electrically Driven Pumping Plants. Illustrated description of two examples of electrically driven pumps, showing practice in Great Britain. 1500 w. Engr, Lond—June 3, 1910. No. 14758 A.

Electric Irrigation Pumping in Kansas. E. C. Reybold, Jr. Brief illustrated description of a station operating fourteen pumping plants. 1200 w. Elec Wld—June 9, 1910. No. 14658.

Brakes.

Hydraulic Brakes with Air Recuperators and Regulators (Les Freins hydrauliques avec Récupérateur à Air et Modérateur). Describes brakes of this type applied to mobile artillery. Ills. 3000 w. Tech Mod—May, 1910. No. 14828 D.

Fire Engines.

The Evolution of the Fire Engine. E. T. Rowland. Brief historical review. 2000 w. Yale Sci M—June, 1910. No. 14775 C.

Pumping Engines.

The New Triple-Expansion Pumping Engines of the Hamburg Water Works (Die Neuen Dreifach-Expansions-Pumpmaschinen des Hamburger Wasserwerkes). Rud. Schröder. Illustrated detailed description of the engines and plant. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15076 D.

Rams.

The Theory of a New, Large-Capacity Hydraulic Ram with Positive Valve Gear (Theorie eines neuen hydraulischen Widders mit Zwangläufiger Steuerung für grosse Wassermengen). Mathematical. Ills. 5000 w. Glasers Ann—May 15, 1910. No. 14892 D.

Turbine Design.

Notes on the Design of a Radial Inward-Flow Hydraulic Turbine. Claud H. Hill. Indicates the methods usually followed. Mathematical. 600 w. Can Engr —May 27, 1910. No. 14487.

Turbine Governors.

The Theory of Plate Spring Governors (La Thèorie des Régulateurs à Ressorts lamellaires). R. Loewy. A mathematical discussion of their design, with special reference to their application to hydraulic turbines. Ills. 7500 w. Rev de Mécan—May, 1910. No. 15084 E + F.

Turbines.

Comparison of the Characteristic Features of Special and Stock Hydraulic Turbines. H. Birchard Taylor. The general features are compared and the fields of the two classes discussed. 4000 w. Eng News—May 26, 1910. No. 14405.

Modern American Hydraulic-Turbine Construction (Moderner amerikanischer Wasserturbinenbau). Wilhelm Müller. The first part deals with installations by James Leffel & Co., Springfield, O. Ills. Serial. 1st part. 1800 w. Zeitschr f d Gesamte Turbinenwesen — May 10, 1910. No. 14879 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Design of Ball Thrust Bearings. Henry Hess. Explains the way in which the surface forming the seat or ball race affects the efficiency and life of a ball bearing. Ills. 700 w. Am Mach—Vol. 33. No. 23. No. 14679.

Ball Levers.

Ball Levers and Drilling Jig. Illustrates and describes a typical ball lever, giving proportions used by a firm of machine tool makers. 500 w. Prac Engr—May 20, 1910. No. 14454 A.

Cams.

Developing a Cam Groove in a Cam Pattern. J. R. Moorhouse. Illustrated description of the method. 700 w. Mech Wld—May 27, 1910. No. 14614 A.

Dies.

Designing Dies Economically. Guido Sacerdote. How to design dies in order to obtain the least waste in spacing of blanks. Ills. 500 w. Am Mach—Vol. 33. No. 24. No. 14789.

Flexure.

Limitations of the Common Theory of Flexure. John S. Myers. A discussion of the design of curved machine members under eccentric load, stating conclusions. 5500 w. Mach, N Y—June, 1910. No. 14527 C.

Fly Wheels.

Explosion of a Fly-Wheel. An illustrated article describing the plant, the explosion and damage, and discussing the cause. 3000 w. Locomotive—April 25, 1910. No. 15048.

Gears.

Table of Angles and Circular Pitches for Spiral Gears. Gives a table arranged for the use of designers of spiral gears. 2000 w. Engr, Lond—June 17, 1910. No. 15239 A.

Piston Rings.

Piston Rings—Their Design and Manufacture. Stanley M. Udale. Mathematical study. 2000 w. Horseless Age—June 22, 1910. No. 15211.

Presses.

The Design of Friction Presses (Note sur le Calcul des Presses à Friction). Herr Schlessinger. Translated from

Zeitschrift des Vereins Deutscher Ingenieure. Ills. 8000 w. All Indus—May, 1910. No. 14831 D.

Screw Threads.

The Screw-Thread Commission (Commission des Filetages). M. Sebert. A report on the standardization of screw threads presented at the congress held in connection with the Brussels exposition on behalf of the French Society for the Encouragement of National Industry. 2000 w. Bul Soc d'Encour—April, 1910. No. 14818 G.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

Making Re-Melted Spelter from Sheet Zinc Scrap, Zinc Routings, Battery Zincs. Engravers' Zinc, Etc. Illustrated article describing the treatment of the various forms of zinc found on the market in such condition that remelting and pouring will give good spelter. 2000 w. Brass Wld—June, 1910. No. 14720.

Burnishing.

Lathe Burnishing of Metals. William A. Painter. General remarks with illustrated description of a method of burnishing much used. 2000 w. Mach, N Y—June, 1910. No. 14528 C.

Chain Making.

The Manufacture of Driving Chains. Illustrated description of works and methods of Messrs. Hans Renold, Manchester, Eng. 2000 w. Elec Rev, Lond—May 20, 1910. No. 14446 A.

Core Ovens.

Drying-Oven Doors (Die Trockenkammer-Verschlusstüren in ihrer Anwendung). H. Vetter. Describes a number of types. Ills. Serial. 1st part. 1500 w. Giesserei-Zeit—May 1, 1910. No. 14863 D.

Cupola Practice.

Chemistry and Cupola Practice. W. W. Cox. Read before the Kansas City branch of the Am. Chem. Soc. Considers the combined carbon content of machinery castings. 1200 w. Ir Age—June 16, 1910. No. 14901.

Chemistry and Cupola Practice. W. W. Cox. Discusses the causes of variations in physical and chemical properties of grey iron. 1500 w. Foundry—June, 1910. No 14593.

Dies.

Dies for Offsetting Steel Angles. S. Hurley. Illustrates and describes a die that requires but one operation of a hydraulic press to shape two pieces and also produce angles shaped right and left. 1200 w. Am Mach—Vol. 33. No. 25. No. 15127.

Out-of-Date Die-Making Methods. F. E. Shailor. An illustrated comparison of old and modern methods. 1500 w. Mach, N Y—June, 1910. No. 14530 C.

Enamelling.

Enamelled Cast-Iron Sanitary Ware. Dillen Underhill. Describes the cooling ovens and arrangement of the enamelling room, and method of crating tubs and lavatories. 3000 w. Foundry—June, 1910. No. 14596.

Extrusion Presses.

The Extrusion of Metals in the Solid State. Discusses its limitations and most useful applications, illustrating presses for different kinds of work. 2000 w. Ir Age—June 23, 1910. No. 15116.

Foundries.

Model Foundry for Casting Iron. E. F. Lake. Illustrated description of a foundry in Providence, R. I., which uses machinery wherever possible to effect a saving in labor. 1500 w. Am Mach—Vol. 33. No. 23. Serial. 1st part. No. 14676.

Foundry Coke.

Specifications for Foundry Coke. Dr. Richard Moldenke. Read before the Am. Found. Assn. Suggested specifications, with general remarks. 1400 w. Ir Age—June 16, 1910. No. 14902.

Foundry Design.

Economizing Space in the Foundry. Walter J. May. Suggestions for making the most of restricted floor space. 900 w. Prac Engr—June 3, 1910. No. 14740 A.

Foundry Flasks.

Shaped Flasks for Special Castings. Walter J. May. Brief remarks on when the cost of shaped flasks is warranted, giving examples. Ills. 700 w. Prac Engr—May 20, 1910. No. 14456 A.

Foundry Furnaces.

The "Anthony" Oil Melting Furnace. Illustrates and describes this type of metal melting furnace. 600 w. Brass Wld—June, 1910. No. 14723.

Foundry Practice.

Foundry Efficiency. Benjamin D. Fuller. Reports some methods which have been proven successful. 1000 w. Am Found Assn—June, 1910. No. 15107 N.

Galvanizing.

Some Chemical Engineering Problems. C. F. Burgess. Explains a few problems illustrating the nature of the work in chemical engineering, relating principally to galvanizing processes. 2000 w. Wis Engr—June, 1910. No. 14929 D.

Gear Cutting.

Why Gear Hobbing Machines Cut Flats. George B. Grant. A demonstration of the difficulties encountered in the use of the hob for generating spur and spiral gear teeth. Ills. 1200 w. Am Mach—Vol. 33. No. 25. No. 15126.

Grinding.

Economy in Grinding. J. J. Thacher. Suggestions for use of the Brown and Sharp grinders. Ills. 1500 w. Prac Engr—May 27, 1910. No. 14610 A.

Examples in Modern Grinding Practice. H. Darbyshire. Practical suggestions. 2500 w. Am Mach—June 16, 1910. No. 14794.

Grinding Machines.

Natural and Artificial Grinding Wheels

(Meules en Grès et Meules artificielles). G. Dumont. A discussion of safety devices applied to grinding wheels. Ills. 4000 w. Tech Mod—May, 1910. No. 14829 D.

Lathes.

A Comparison of Lathe Headstock Characteristics. Prof. Walter Rautenstrauch. Discusses a comparison made on the basis of those characteristics of speed and torque in a lathe headstock which permit the most economic removal of shavings from a given class of material. 3000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14944 F.

Back Gearing for Lathes. The principles of designing lathe cone steps, and double back gear ratios to give suitable speed changes without duplication. 1500 w. Am Mach—Vol. 33. No. 25. No. 15125.

Cone Drive versus Gear Drive. A discussion by William Lodge and R. K. LeBlond favoring the cone pulley. 3500 w. Ir Age—June 2, 1910. No. 14526.

Erecting and Testing a Lathe. T. Metcalfe. (Prize paper.) Drawings and detailed description. 1800 w. Mech Wld—June 3, 1910. Serial. 1st part. No. 14742 A.

A Large Lodge & Shipley Crankshaft Lathe. Illustrates and describes details of the crankshaft turning attachment. 1000 w. Ir Age—June 23, 1910. No. 15119.

Machine Tools.

The Automobile and Machine Tools. Robert Pierpont. Read before the Nat. Machine Tool Bldrs. Assn. Discusses the future of this new industry and its relation to machine design. 3500 w. Ir Age—June 2, 1910. No. 14482.

Machine Tools at the International Motor Boat and Motor Exhibition (Werkzeugmaschinen auf der Internationalen Motorboot- und Motoren-Ausstellung 1910). A. H. Simon. Describes the exhibits. Ills. Serial. 1st part. 1500 w. Motorwagen—May 10, 1910. No. 14889 D.

Milling Machines.

The No. 4 Hendey Universal Milling Machine. Illustrates and describes interesting details of a new dividing head ana other mechanisms. 800 w. Ir Age—June 2, 1910. No. 14485.

Molds.

Iron Molds for Making Castings. Illustrated description of methods developed by Edgar A. Custer, Tacony Ironworks, Philadelphia. 2000 w. Engr, Lond—June 17, 1910. Serial. 1st part. No. 15238 A.

Molding.

Molding Bulldozer Frame. Jabez Nall. Illustrated description of method used. 2500 w. Am Mach—Vol. 33. No. 25, No. 15128.

Molding Circular Segment Plates. G. Buchanan. Illustrates and describes details of the construction of the pattern and the making of the castings. 1000 w. Foundry—June, 1910. No. 14594.

Molding Machines.

A Few Problems in Machine Molding. Illustrates and describes shop work where 169 molding machines of seven different types are operated. 3500 w. Foundry—June, 1910. No. 14592.

Recent Special Molding Machines of the United Emery and Machine Co., Hannover-Hainholz (Neuere Sonderformmaschinen der Vereinigten Schmirgel- und Maschinen-Fabriken A.-G., Hannover-Hainholz). R. Lüssenhop. Describes machines for moulding smoothing irons, pots, etc. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15077 D.

Pattern Making.

Pattern Cock and Valve Work. Joseph Horner. Illustrated discussion of some of the difficulties and problems. 2500 w. Mech Wld—June 10, 1910. Serial. 1st part. No. 15036 A.

Patternmaking for Bulldozers. Jabez Nall. Illustrates and describes the procedure in making patterns for Ajax high speed bulldozer. 1700 w. Am Mach—Vol. 33. No. 22. Serial. 1st part. No. 14499.

Pneumatic Tools.

The Maintenance, Care and Up-Keep of Pneumatic Hammers. George H. Hayes. Remarks on the abuses which these tools receive. 1500 w. Mach, N Y—June, 1910. No. 14532 C.

A New Compressed Air Hammer. Illustrated description of a machine in which air under pressure is supplied from an independent plant. 1200 w. Engr, Lond—May 20, 1910. No. 14478 A.

Safety Devices.

Shall Manufacturers be Obliged by Law to Protect Gearing (Soll den Maschinenfabrikanten die Verkleidung der Zahn- und Kettenräder gesetzlich vorgeschrieben werden)? Georg Urban. Discusses the accidents caused by exposed gears and the arguments for forcing manufacturers to protect them. 2000 w. Tech u Wirt—May, 1910. No. 15080 D.

See also Grinding Machines, under MACHINE WORKS AND FOUNDRIES.

Screw Cutting.

Threading Operations. Douglas T. Hamilton. Illustrates and describes practice for the Brown & Sharpe automatic screw machine. 4500 w. March, N Y—June, 1910. Serial. 1st part. No. 14529 C.

Shears.

Universal Shears for Channels, Angles, and Plates. Brief description, with illustrations. 300 w. Engng—May 27, 1910. No. 14620 A.

Shop Design.

Metal-Working Plants and Their Machine-Tool Equipment. Charles Day. This second of two articles deals with the characteristics of plants for machinery building and repairs. 5000 w. Engineering Magazine—July, 1910. No. 15261 B.

Shop Floors.

Wearing Surface for Factory Floors. Information from a recent report giving a summary of replies to inquiries about granolithic or other masonry floors, and wood-top floors. 3000 w. Eng Rec—May 28, 1910. No. 14415.

Shop Practice.

Some Causes of Faulty Work. Considers points from a general viewpoint, applicable to works of various classes. Discusses drawings, methods of indicating dimensions, and fixing allowances, in the present number. 1500 w. Prac Engr—June 3, 1910. Serial. 1st part. No. 14741 A.

Machine Efficiency. Oscar E. Perrigo. Suggests methods of improving the ratio between expense and output in machine tool equipment. 4000 w. Ir Trd Rev—Jnue 23, 1910. No. 15146.

Shop Kinks. Illustrates and describes practice at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul. 1200 w. Ry Age Gaz—June 3, 1910. No. 14543.

The Manufacture of Frogs and Switches. J. B. Haskell. Illustrated description, based especially on the practice of the American Frog and Switch Co. of Hamilton, Ohio. 1800 w. Mach, N Y—June, 1910. No. 14531 C.

Making Walschaerts Valve Gear Parts. Ralph E. Flanders. Explains the advantages of this gear and gives illustrated description of the various operations in its manufacture. 3500 w. Mach, N Y—June, 1910. No. 14533 C.

Finishing Stay-Bolts and Straight and Taper Bolts for Locomotives. C. K. Lassiter. Illustrates and describes the methods and devices used. 2000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14945 F.

New Cincinnati Planer Shops. Illustrated description, with explanation of methods used in building planers. 1800 w. Am Mach—Vol. 33. No. 23. No. 14680.

Heavy English Equipment Tools. I. W. Chubb. Methods of building heavy equipment are illustrated and described. 3000 w. Am Mach—Vol. 33. No. 25. No. 15124.

Building the Maxwell Automobile. Interesting operations and special fixtures are illustrated and described. 1600 w. Am Mach—Vol. 33. No. 22. No. 14497.

Making Gun Stocks and Receivers. Frank A. Stanley. Illustrates and describes methods of turning and finishing gun stocks and machining receivers. 2000 w. Am Mach—June 9, 1910. No. 14678.

Manufacturing Shot Gun Barrels. Frank A. Stanley. Illustrates and decribes the more important and interesting processes. 3500 w. Am Mach—Vol. 33. No. 22. No. 14496.

Revolver and Rifle Barrel Work. Frank A. Stanley. Illustrates and describes machines, attachments, and methods for accomplishing accurate results. 2000 w. Am Mach—Vol. 33. No. 24. No. 14788.

Milling and Accurate Machine Slide. A. J. Baker. Gives illustrated details of the fixtures, cutters, and gauges employed, and a record of speeds and feeds used. 1600 w. Am Mach—Vol. 33. No. 22. No. 14498.

Machining Aluminum Crank Cases. Illustrates and describes fixtures and tools used to secure large outputs by rapid methods. 1200 w. Am Mach—Vol. 33. No. 24. No. 14793.

Rigging Up to Make a Spiral Sleeve. Describes how the various operations were accomplished with special fixtures rigged up on the planer. Ills. 2000 w. Am Mach—Vol. 33. No. 24. No. 14792.

Shops.

See Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Welding.

Electrical Welding. Briefly describes the arc process, and the resistance process. 1200 w. Prac Engr—May 20, 1910. No. 14455 A.

Incandescent Welding. C. B. Aull. Briefly describes the LaGrange-Hoho and the Thompson processes and illustrates and describes typical examples of welding machines. 3500 w. Elec Jour—June, 1910. No. 14770.

Electric Spot Welding. A. E. Buchenberg. Describes methods, machines and applications of the spot-welding process. 1600 w. Elec Wld—June 2, 1910. No. 14503.

The Oxy-Acetylene Welding Process. J. F. Springer. Illustrated article considering its chemical reactions and typical applications to foundry repairs. 3000 w. Ir Age—June 16, 1910. No. 14904.

Autogenous Welding in a Railway Shop. H. W. Jacobs. Illustrates and describes the plant and methods of the A. T. & S. F. 2200 w. Ry Age Gaz—June 17, 1910. No. 14975.

Investigations of Autogenous Welding of Plates and Boiler Parts (Versuche mit autogen geschweissten Blechen und Kesselteilen). C. Bach. A brief review of the results of tests by the International Association of Boiler Inspection Companies. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—May 21, 1910. No. 15075 D.

See also same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Woodworking Machines.

The Speed of Woodworking Machine Tools. James F. Hobart. A discussion of power economy, and of the merits of the group plan or separate motor for machine drives. 2500 w. Wood Craft—June, 1910. No. 14548.

Woodworking Machines at the Brussels Exhibition. Illustrates and describes a horizontal log band-mill, and a wood-planing and matching machine, and briefly considers other machines shown. 1500 w. Engng—May 20, 1910. No. 14466 A.

MATERIALS OF CONSTRUCTION.

Alloys.

See Thermo-Electric Properties, under ELECTRICAL ENGINEERING, Electro-Physics.

Alloy Steels.

Vanadium Steel. William E. Gibbs. Considers its properties and advantages. 4000 w. Cassier's Mag—June, 1910. No. 14642 B.

Cast Iron.

Chemical Standards for Iron Castings. Extract from the report of the Committee on Standards for Iron Castings, giving a large collection of analyses. 3000 w. Am Found Assn—June, 1910. No. 15106 N.

Metallography.

A Magnetic Holder for the Microscopical Examination of Metals. Albert Sauveur. Illustrated description of the device. 600 w. Ir Age—June 23, 1910. No. 15117.

The Microscope and Some of Its Applications to Metallurgy. Wirt Tassin. Read before the Phila. Found. Assn. An illustrated microscopic study of metal structure. 2500 w. Ir Age—June 9, 1910. No. 14652.

Microscopic Metallography and its Industrial Applications (La Métallographie microscopique et ses Applications industrielles). Léon Guillet. A report of a practical address on this subject. Ills. 3000 w. Tech Mod—May, 1910. No. 14824 D.

Segregation of Metalloids in Steel. S. S. Knight. Observations on this phenomenon, giving results of research work in the field of the silicon-iron compounds. Ills. 1200 w. Foundry—June, 1910. No. 14595.

Steel.

The Hardness of Steel. George Auchy. Explains static and dynamic hardness, discussing the Brinell, and Shore tests, and points to be kept in mind in making them. 2200 w. Ir Age—June 9, 1910. No. 14654.

Tin.

The Contagious Diseases of Metals. An illustrated account of the researches of Prof. Ernest Cohen. 2500 w. Sci Am—June 25, 1910. No. 15142.

The Diseases of Metals (De Forceerziekte der Metalen). Ernst Cohen. A discussion of the corrosion of tin. Ills. 7000 w. De Ingenieur—May 7, 1910. No. 15081 D.

Type Metal.

Type, Electrotype, Linotype, Stereotype and Monotype Metals. Alfred McCue. Considers metals for casting type. 900 w. Brass Wld—June, 1910. No. 14722.

MEASUREMENT.

File Testing.

German File Testing Machine. Dr. Alfred Gradenwitz. Illustrates and describes a machine for testing the quality of files. 1500 w. Am Mach—Vol. 33. No. 23. No. 14677.

Flywheel Testing.

Topical Discussion on Recent Developments in Wheel Testing. Dr. C. H. Benjamin. Reviews the progress in this kind of experimentation since the first work reported in 1898. Illustrates and describes the testing pit recently established at Purdue University. 2000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14950 F.

Gauging.

Gauging Cylindrical Bores. Explains method and necessary calculations. 1000 w. Mech Wld—May 20, 1910. No. 14461 A.

Deformations.

New Apparatus for Measuring Deformations in Materials. H. C. Berry. Illustrates and describes an apparatus made in the shop of the University of Pennsylvania for accurate measurement of deformations of webs of beams, etc. 900 w. Eng Rec—June 11, 1910. No. 14694.

Manometers.

The Accuracy of High-Pressure Measuring Instruments (Der Genauigkeitsgrad von Hochdruckmessern). G. Klein. Describes and reports tests on manometers of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—May 14, 1910. No. 15074 D.

Pipe Testing.

The Testing of Pipes and Cylindrical Shells by Means of Compressed Gas (Su alcune Modalita di Prova dei Tubi e delle Bombe per gas Compressi). F. Giordano. Describes a new apparatus for the measurement of deformations. Ills. 3500 w. Monit Tech—May 10, 1910. No. 14845 D.

Press Testing.

The Cylinder Compression Test for Presses (Das Prüfen von Pressen mit Hülfe von Stauchzylindern). H. Gäntzlen. Describes and gives results obtained with a method of testing presses developed at Lewis Institute, Chicago. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15078 D.

Pyrometry.

Electric Heating and Pyrometry. Abstract of the concluding lecture of Prof. J. A. Fleming on the methods of measuring temperature. Ills. 300 w. Engng—June 17, 1910. No. 15236 A.

Recording Instruments.

Automatic Recording Instruments. Illustrated descriptions of modern registering or recording instruments which particularly appeal to the engineering industries. 2500 w. Mech Engr—June 17, 1910. Serial. 1st part. No. 15233 A.

Screw Testing.

A Machine for Testing the Efficiency of Screws (Machine à Mesurer le Rendement des Vis). Ch. Frémont. Describes a machine for measuring the efficiency of screws used for lifting weights. With a historical note on the origin of screws and gears. Ills. 6000 w. Rev de Mécan—May, 1910. No. 15085 E + F.

Testing Methods.

The Inspection and Testing of Engineering Materials and Machinery. C. W. V. Biggs. Deals with the requirements which can reasonably be expected from various types of machinery, and the best way to ascertain that these requirements are fulfilled. 6500 w. Soc of Engrs—June 6, 1910. No. 14916 N.

Comparison of the Tensile, Impact-Tensile, and Repeated-Bending Methods of Testing Steel. Bertram Blount, W. G. Kirkaldy, and H. Riall Sankey. Report of tests. Ills. 7500 w. Inst of Mech Engrs—May 27, 1910. No. 14747 N.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. Discusses points of construction. 1200 w. Prac Engr—May 27, 1910. No. 14611 A.

Air Compressor Cylinder Ratios. Snowden B. Redfield. Discusses theoretical and practical conditions which give maximum economy in compounding air compressor cylinders. Ills. 3000 w. Power—June 14, 1910. No. 14715.

Air Compression in an Exhaust-Steam Piston Compressor at the Fürstenstein Mines, Waldenburg (Die Presslufterzeugung auf den Fürstensteiner Gruben in Waldenburg durch einen Abdampfkolbenkompressor). Carl Wolff. Describes the plant and gives results. Ills. Serial. 1st part. 5000 w. Glückauf—May 21, 1910. No. 14873 D.

Compressed Air.

Energy of Compressed Air. Snowden B. Redfield. An analysis of the power and heat transformation taking place in an air compressor cylinder. 2500 w. Am Mach—Vol. 33. No. 24. No. 14790.

The Economy of Compressed Air at Various Pressures and Temperatures (Die Wirtschaftlichkeit des Druckluftbetriebes mit verschiedenen Spannungen und Temperaturen). H. Reiser. A practical discussion, based on experimental data. Ills. 5000 w. Glückauf—May 14, 1910. No. 14872 D.

Cost.

Power Investigation in a Grain Mill. Gives details of the analysis of the cost of power service at a large mill in Providence, R. I. 1000 w. Eng Rec—June 11, 1910. No. 14693.

Critical Speeds.

Critical Speed Calculation. S. H. Weaver. Gives a mathematical treatment for both the distributed and the concentrated loads, by considering the motion of the shaft as vibratory along two axes; reduces formulae and gives tables for practical use. 4500 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14948 F.

Electric Driving.

Magnet Switch Control for Driving-Wheel and Car-Wheel Lathes. J. H. Klinck. An illustrated article explaining the advantages of magnet switch control for wheel work. 1500 w. Elec Jour—June, 1910. No. 14773.

The Motor Drive. Richard D. Gatewood. Discusses its use in shops and on ships. Ills. 6000 w. Pro U S Naval Inst—June, 1910. No. 15103 F.

Interaction of Flywheels and Motors When Driving Roll Trains by Induction Motors. F. G. Gasche. An analysis aiming to exhibit the manner of disposition of certain important elements. 3000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14957 F.

Electricity in the Printing Office. Frank Broadbent. Presents the advantages in economy, convenience, increase in output, and quality of work. 2200 w. Elec Rev, Lond—June 3, 1910. No. 14728 A.

Electric Driving of Cotton-Picking Machinery. Albert Walton. An illustrated comparison of direct and group driving. 5000 w. Cassier's Mag—June, 1910. No. 14637 B.

The Electrical Equipment of Messrs. Edward Lloyd, Ltd. Illustrated description of the equipment of this large printing plant. 2500 w. Elec Rev, Lond—June 3, 1910. No. 14729 A.

Lubrication.

Forced Lubrication. R. K. Morcom. Read before the Inst. of Mech. Engrs., London. States some established conclusions, giving particulars of lubrication systems. 1800 w. Automobile—June 9, 1910. Serial. 1st part. No. 14675.

Mechanical Plants.

Mechanical Plant of the Provident Bank Building, Cincinnati. Walter C. Franz. Plans and description of a plant for a 10-story building. 1600 w. Eng Rec—May 28, 1910. No. 14420.

Power Plants.

Some Points Relating to Railway Shop Power Plants. E. M. Rhett. Considers the design and operation of such plants, the functions, and points of interest. General discussion. 1200 w. Pro S & S-W Ry Club—March, 1910. No. 15049 E.

Tidal Power.

Tidal Movements as Motive Power (Utilisation du Flux et du Reflux de la Mer comme Force motrice). J. Séverin. A discussion of the progress made in harnessing tidal power and the possibilities. Ills. 3500 w. L'Elecn—May 28, 1910. No. 14823 D.

STEAM ENGINEERING.

Boiler Draft.

The Prat System of Forced Draft (L'Aspirazione meccanica dei Gas combusti negli Impianti di Caldaie a Vapore secondo il sistema Prat). Illustrated description. 1500 w. Industria—May 8, 1910. No. 14847 D.

Boiler Capacity.

See Thermodynamic Units, under Steam Engineering.

Boiler Management.

A Boiler-Testing Installation and the Economical Combustion of Fuel. Charles Edward Larard. Discusses the maintaining of uniform high boiler efficiency at a minimum of cost. 3500 w. Engng—June 3, 1910. Serial. 1st part. No. 14748 A.

Mechanical and Physical Control of Combustion in Boiler Furnaces (Le Controle mécanique et physique de la Combustion dans les Foyers industriels). Eugène Grandmougin. Describes feed-water meters, differential manometers, and other devices. Ills. 4000 w. Génie Civil—May 7, 1910. No. 14835 D.

Boiler Waters.

The Selection of a Boiler Feed Water. J. C. William Greth. Considers the impurities common to water supplies, and the importance of soft, clear non-corrosive water. General discussion. 11000 w. Pro Engrs Soc of W Penn—May, 1910. No. 15047 D.

Condensers.

The Quantity of Circulating Water Required in Surface Condensers. R. M. Neilson. Discusses the determining of the quantity of water to be used to meet the conditions. 4000 w. Engr, Lond—June 17, 1910. No. 15240 A.

Friction Loss in Surface Condensers. W. Vincent Treeby. Presents curves giving the frictional head of 1, 2, 3, and 4 pass condensers. 400 w. Power—June 14, 1910. No. 14714.

Some New Condensers (Quelques Condenseurs nouveaux). A review of recent condenser literature and patents. Ills. 8500 w. Rev de Mécan—May, 1910. No. 15086 E + F.

See also Turbine Plants, under STEAM ENGINEERING.

Condenser Water.

See Intakes, under CIVIL ENGINEERING, WATER SUPPLY.

Economizers.

Power Plant Economizers. Frank Kingsley. Argument as to the merits of economizers, giving an anaylsis of their efficiency and discussing related matters. 3500 w. Eng Rec—June 4, 1910. No. 14569.

Engine Compression.

Is Compression Economical? Gives results, and conclusions drawn from tests, which proved that the more compression the less power per pound of steam. 10500 w. Power—June 28, 1910. No. 15252.

Engine Cranks.

The Proper Fitting of Engine Cranks. H. S. Brown. Simple and explicit directions. Ills. 1000 w. Power—June 14, 1910. No. 14716.

Engine Erection.

Erecting a 750 I. H. P. Horizontal Tandem Compound Condensing Corliss Engine. H. Graham. Drawings with detailed description. 1500 w. Prac Engr—June 17, 1910. No. 15230 A.

Engine Governors.

Charles Beer's Theory of Engine Governors (Théorie de M. Charles Beer sur les Régulateurs de Vitesse). V. Dwelshauvers-Dery. A mathematical exposition and criticism of this theory. Ills. 9000 w. All Indus—May, 1910. No. 14830 D.

Engines.

The Revival of the Reciprocating Engine. R. J. S. Pizott. This first article of a series deals with thermal characteristics and problems of design of combination steam plants. Ills. 3000 w. Engineering Magazine—July, 1910. No. 15263 B.

See also Rotary Engines, under STEAM ENGINEERING.

Engine Testing.

Apparatus for Measuring Feed Water on Marine-Engine Trials. Illustrated description of the tank arrangements which the Stettiner Maschinenbau-Aktien-Gesellschaft Vulcan uses. 500 w. Engng—May 27, 1910. No. 14619 A.

Feed-Water Heating.

Feed Water Heating in a Cotton Mill. Harvey B. Mann. Gives an analysis of cost and returns for various systems. 1200 w. Sib Jour of Engng—June, 1910. No. 14933 C.

Fuel Purchasing.

The Purchase of Coal on an Efficiency Basis. A. O. Doane. Points out some considerations governing a purchaser of fuel, showing the effect of impurities and constituents, considers tests, specifications and the subject generally. Discussion. 7500 w. Jour N Eng W-Wks Assn—June, 1910. No. 14936 F.

Analyses and Buying of Steam Coal. From the report of the committee on fuel supply, Boston Chamber of Commerce. 4000 w. Ry Age Gaz—June 24, 1910. No. 15156.

Fuel Testing.

Federal Investigations of Mine Accidents, Structural Materials, and Fuels, at the United States Testing Station, Pittsburg, Pa. Discussion of Herbert M. Wilson's paper. 5000 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14942 E.

Indicators.

Continuous Records from Indicator. N. L. Daney. An illustrated description of an electrically-controlled system, which gives simultaneous diagrams from both ends of all cylinders, and automatically records such information as is required for power calculations. 2200 w. Power—May 31, 1910. No. 14428.

Mechanical Stokers.

Early History of Stokers in England. J. F. Springer. Illustrated review of early automatic stokers. 3500 w. Power—June 7, 1910. No. 14598.

Side Feed Automatic Stokers. J. F. Springer. An illustrated résume of this type of stoker, giving typical installations of present day practive. 2500 w. Power—June 14, 1910. No. 14713.

Mechanical Stoking of Steam Boilers (Conduite mécanique de la Chauffe dans les Foyers des Générateurs de Vapeur). M. Emanaud. An exhaustive discussion of the theory of stoking and the advantages of mechanical stokers. Serial. 1st part. 3500 w. Génie Civil—May 28, 1910. No. 14844 D.

Rotary Engines.

The Herrick Rotary Engine. Illustrated description of an engine with a steam balanced rotor. 2500 w. Ir Age—June 2, 1910. No. 14483.

Herrick Balanced Rotary Engine. Illustrates and describes the mechanical details of a new type of rotary engine. 1000 w. Power—May 31, 1910. No. 14430.

Steam Piping.

Steam Piping at Collieries and Ironworks. Discusses important considerations which arise in this connection. 2200 w. Col Guard—June 10, 1910. No. 15037 A.

Piping for the Steam Plant. Percival R. Moses. From an article in *The Isolated Plant*. Information and suggestions for a safe system of piping. 2500 w. Am Gas Lgt Jour—June 6, 1910. No. 14550.

Thermal Storage.

Thermal Storage. Illustrates and describes the Druitt-Halpin system as installed by St. Pancras Dept. for the King's-road works. 1400 w. Engr, Lond—June 3, 1910. No. 14759 A.

Thermodynamic Units.

Two Proposed Units of Power. Prof. William T. Magruder. Suggestions for new unit to measure the capacity of a boiler; and a new unit for the capacity of a gas producer, coke oven, or blast furnace to deliver available heat energy. 3000 w. Jour Am Soc of Mech Engrs—June, 1910. No. 14946 F.

Turbine Design.

A Heat Diagram for Use in Turbine Design. John Morrow. Gives diagram explaining its construction and use. Plates. 2000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1910. No. 15145 N.

Turbine Economy.

The Effect of Vacuum on the Economy of Steam Turbines. R. M. Neilson. Explains why the efficiency of a turbine is affected by change in the terminal pressure. 1800 w. Elect'n, Lond—June 17 1910. No. 15229 A.

Turbine Plants.

Extensions to Electricity Supply Stations by Means of Mixed Pressure Turbines. Ashton Bremner. Describes an installation at Burslem and gives particulars of the saving obtained. 500 w. Elect'n, Lond—June 17, 1910. No. 15227 A.

Exhaust Steam Turbines and Condensing Plant at McDonald Road Station. F. A. Newington. Describes turbines recently installed in Edinburgh. Sewage is used for condensing purposes. 2500 w. Elect'n, Lond—June 17, 1910. No. 15226 A.

Turbines.

300-Horse-Power Impulse Steam-Turbine. Illustrations and description of the principal features of the machine of the multicellular impulse type. 1000 w. Engng—June 3, 1910. No. 14750 A.

Barbezat Steam Turbine. P. Andre. Illustrated description of a new turbine which is essentially a combination of the DeLaval and Parsons types. 1000 w. Mech Engr—May 27, 1910. No. 14613 A.

The A. E. G. Steam-Turbine. Illustrated description of a 2000-kilowatt velocity-compounded steam-turbine having but two pressure stages, and two wheels per stage. 2500 w. Engng—May 20, 1910. No. 14465 A.

The Elektra Steam Turbine. Dr. H. Meuth. Illustrates and describes its construction and operation, and considers fields of use. 4000 w. Jour Am Soc of Naval Engrs—May, 1910. No. 15088 H.

The Oerlikon Series-Parallel Turbine for Either Exhaust or Live Steam (Turbine "série-parallèle" Oerlikon fonctionnant avec de la Vapeur d'Echappement et de la Vapeur fraîche). Describes the turbine and gives results of tests. Ills. 2000 w. Génie Civil—May 7, 1910. No. 14837 D.

Recent Examples of Steam-Turbine Construction (Neuere Konstruktionen von Dampfturbinen). K. Körner and F. Lösel. The first part discusses the development of the small steam turbine in America. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—May 7, 1910. No. 15071 D.

Turbine Testing.

Testing Steam Turbines With a Water Brake. Winslow H. Herschel. Discusses the proper method of taking readings of speed and torque in such tests. 1200 w. Harvard Engng Jour—May, 1910. No. 14779 D.

Valves.

Two New Valves. Illustrated description of a new steam controlling valve, and a combined check and steam valve. 1200 w. Engr, Lond—June 17, 1910. No. 15247 A.

Watt Museum.

Museum of Watt Developments. I. W. Chubb. Illustrated account of the famous drawings, letters and other relics contained in the Tangye Museum, Birmingham, Eng. 4500 w. Power—June 21, 1910. No. 15011.

TRANSPORTING AND CONVEYING.

Coal Handling.

Coal Handling Plant of the Radzionkau Mine in Upper Silesia (Die Verladeanlage der Radzionkaugrube in Oberschlesien). M. Buhle. Describes an elaborate car haulage, dumping and storage plant, built by Ernst Heckel. Ills. 5500

w. Zeitschr d Ver Deutscher Ing—May 7, 1910. No. 15072 D.

Conveyers.

Notes on Conveyors. Remarks on the many applications, types suited to various conditions, etc. 4000 w. Mech Wld—May 27, 1910. No. 14615 A.

Cranes.

Electrically-Driven Shipyard Cranes. H. H. Broughton. Considers details that the performance of all types of electric cranes, and illustrates and describes several systems. 6500 w. Elect'n, Lond—June 10, 1910. No. 15022 A.

Freight Handling.

See Terminals, under RAILWAY ENGINEERING, Permanent Way and Buildings.

MISCELLANY.

Aerodynamics.

An Aerodynamic Laboratory (Installation d'un Laboratoire d'Aérodynamique). G. Eiffel. Brief description of the author's new laboratory in Paris and some of the results obtained. Ills. 4500 w. Tech Mod—May, 1910. No. 14827 D.

Aeronautics.

Automatic Stability in Aeroplanes. Adapted from the German of R. Conrad by Marius G. Krarup. Extract of the reasoning on the subject of the available mechanical expedients for avoiding loss of balance. Ills. 1000 w. Automobile—June 2, 1910. Serial. 1st part. No. 14534.

Ferber's Theory of Aeroplane Stability. A detailed account of Captain Ferber's analysis. Mathematical. 3500 w. Engng—May 20, 1910. No. 14473 A.

Studies in Aviation Theory and Practice. Marius G. Krarup. Briefly considers sustentation, equilibrium, propulsion and materials. 2000 w. Automobile—May 26, 1910. Serial. 1st part. No. 14411.

Aviation in Theory and Practice (Der heutige Stand der Flugtechnik in Theorie und Praxis). F. Bendemann. A discussion of the present status of aeronautics. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—May 14, 1910. No. 15073 D.

Aeroplane versus Dirigible. Editorial discussion of the use of the two machines in warfare. 1700 w. Engng—June 3, 1910. No. 14751 A.

How Airships Are Likely to Affect War. B. Baden-Powell. Discusses briefly the capabilities and difficulties of airships, the uses to which they may be applied, and matters related. General discussion follows. 14500 w. Jour Roy U S Inst—May, 1910. No. 14649 N.

The Albany-New York Aeroplane Flight. An illustrated account of the flight of Glenn H. Curtiss on May 29, 1910. 2000 w. Sci Am—June 11, 1910. No. 14668.

Clocks.

Mechanical Clocks (L'Horlogerie mécanique). Léopold Reverchon. A review of the invention and development of clocks, modern progress, the clock industry, etc. Ills. 10000 w. Rev Gen d Sci—May 30, 1910. No. 14821 D.

Textile Machinery.

Textile Machinery at the Brussels Exhibition. Illustrates and describes the exhibits of cotton machinery, showing modern development. Plates. 4000 w. Engng—June 3, 1910. No. 14749 A.

See also Electric Driving, under Power and Transmission.

Vacuum Cleaners.

Carey's Vacuum Cleaning and Disinfecting Apparatus. Illustrated description of a rather novel type of portable vacuum cleaning apparatus. 1000 w. Engng—May 20, 1910. No. 14468 A.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Accidents in the Coal Mines of the U. S., 1909. Edward W. Parker. Reviews the statistics of accidents in different states since 1884, discussing causes. 4500 w. Min Wld—June 25, 1910. No. 15217.

Alberta.

The Galt Coal Field, Alberta. W. D. L. Hardie. Brief description. 1200 w. Qr Bul Can Min Inst—April, 1910. No. 15187 N.

The International Coal & Coke Co.'s Colliery at Coleman, Alta. G. L. Burland. Illustrated description. 6500 w. Jour Can Min Inst—1909. No. 15178 N.

Australia.

The West-Moreton Coal Mines. J. A. Thomas. An illustrated account of the expansion of the industry and the advantages of coal-cutting machines. 1500 w. Queens Gov Min Jour—April 15, 1910. No. 14604 B.

Blasting.

Firing Black Powder by Electricity. Illustrates and describes apparatus for firing either black powder or permitted explosives with safety and economy. 2500 w. Mines & Min—June, 1910. No. 14564 C.

A Commercial Fuel-Briquette Plant Discussion of paper by W. H. Blauvelt. 4000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15099 F.

Coking.

The Production and Use of Coke. W. Hartman. Considers the suitable coals, qualities of the different cokes, etc. 1500 w. Eng & Min Jour—June 4, 1910. No. 14576.

Electric Power.

The Earthed Concentric System for Direct-Current Colliery Cables. W. Bolton Shaw. Read before the Inst. of Min. Elec. Engrs. Discusses insulating methods of installation, and special points to be observed. General discussion. 8500 w. Ir & Coal Trds Rev—June 17, 1910. No. 15249 A.

Explosions.

Explosions from Coal Dust in English Mines. James Stead. Describes experiments made and states the facts established. 3000 w. Min Wld—June 18, 1910. No. 15007.

See also Testing Stations, under COAL AND COKE.

Geological Predictions.

Geological Predictions—A Mystery to Many. Arthur Lakes. Explains how a geologist predicts the presence of coal, oil, artesian water, etc., at a certain depth when there are no surface indications. Ills. 2500 w. Min Wld—June 4, 1910. No. 14587.

Kansas.

The Kansas State Coal Mine. C. M. Young. Describes methods at a mine where convicts are employed to mine coal for state institutions. 2500 w. Eng & Min Jour—June 4, 1910. No. 14575

Mine Dust.

An Analysis of the Coal Dust Problem. Audley H. Stow. Showing the quantity of dust necessary to produce an explosion, and giving suggestions for greater safety. 5000 w. Eng & Min Jour—June 18, 1910. No. 14988.

Some Memoranda Concerning Coal Dust and the Essential Principles of the Coal-Dust Theory. A. W. G. Holbaum. From a paper read before the Inst. of Min. Engrs. An explanation of the coal-dust theory and the remedies. 2500 w. Col Guard—June 3, 1910. No. 14744 A.

Experiments Illustrative of the Inflammability of Mixtures of Coal Dust and Air. P. Phillips Bedson. Read before the Inst. of Min. Engrs. Report of experiments and results. 2500 w. Ir & Coal Trds Rev—June 3, 1910. No. 14760 A.

Coal-Dust Experiments at the Testing Gallery in the Rossitz District (Versuche mit Kohlenstaub im Versuchsstollen des Rossitzer Steinkohlenreviers). Herrn Czaplinski and Jicinsky. Second report. Ills. Serial. 1st part. 3000 w. Oest Zeitschr f Berg u Huttenwesen—May 28, 1910. No. 14868 D.

Mine Gas.

A Study of Flame Caps. George Hiram Winstanly. Describes apparatus for demonstrating the height of flame cap produced by a given percentage of gas. 5000 w. Mines & Min—June, 1910. No. 14565 C.

Mine Shops.

General Lay-Out and Equipment of a Complete Set of Engineering Shops for a Modern Colliery, with an Output of About 2000 Tons Per Day. C. W. Jordan. Second Lewis prize paper. Read before the S. Wales Inst. of Engrs. Ills. 3500 w. Ir & Coal Trds Rev—May 27, 1910. No. 14630 A.

Mining.

Present Greatest Need of Mining. J. T. Beard. Considers existing conditions and some remedies. 3800 w. Mines & Min—June, 1910. No. 14562 C.

Coal Mining by the Monks. Presidential address before the Inst. of Min. Engrs. Reviews coal mining from its earliest beginnings, especially when chiefly carried on by the monks. 7000 w. Col Guard—June 3, 1910. No. 14746 A.

Methods of Mining Lignite in Italy. Charles R. King. Illustrates and describes the methods used. 4500 w. Eng & Min Jour—June 4, 1910. No. 14579.

Method of Working a Steep Coal Seam. Austin Y. Hoy. Gives details of a system used at Coal Creek mine in a seam pitching 38 degrees. 2000 w. Eng & Min Jour—June 25, 1910. No. 15202.

Safety Precautions in Alabama Coal Mines. E. A. Coxe. The electric shot firing system and mechanical means for getting coal are being adopted. Ills. 2500 w. Eng & Min Jour—June 4, 1910. No. 14577.

Mining Costs.

The Cost of Producing Coal. H. F. Bulman. Detailed discussion of the elements of cost. 2500 w. Col Guard—May 19, 1910. No. 14463 A.

Mining Plants.

See Shaft Sinking, under MINING.

Netherlands.

A Comparative Study of the Coal Fields of Northern Europe. John Kirsopp, Jr. A study based upon the memoirs recently published by the Government Institute for the Geological Exploration of the Netherlands. Map. Editorial. 3500 w. Min Jour—May 21, 1910. Serial. 1st part. No. 14453 A.

Nova Scotia.

Coal Mining in Pictou County, Nova Scotia. J. R. Rutherford. Illustrates and describes the coalfield and its development. 4500 w. Jour Can Min Inst—1909. No. 15181 N.

The Caledonia Coal Mine, Dominion No. 4, Glace Bay, C. B. Eugene P Cowles. Illustrated description of the mine and methods. 5000 w. Jour Can Min Inst—1909. No. 15177 N.

Origin.

A Geologist's Notes on the Origin of Coal. J. A. Udden. Read before the Nat. Assn, of San. Engrs. Explains briefly the geological explanation of the origin as at present understood. 3000 w. Min Wld—June 4, 1910. No. 14590.

The Alteration of Vegetable Matter Into Coal. D. B. Dowling. Discusses conditions which may have influenced the transformation and caused variations. 2800 w. Qr Bul Can Min Inst—April, 1910. No. 15186 N.

Peat.

See Gas-Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pennsylvania.

The Northern Appalachian Coalfield. Rush N. Hosler. A detailed study of the various seams and the general character of the basin. 3500 w. Eng & Min Jour—May 28, 1910. No. 14426.

Rescue Appliances.

Oxygen Breathing Apparatus in Coal Mines with a Paragraph on the Rescue Station of the Dominion Coal Co., Glace Bay, Cape Breton. F. W. Gray. Outlines the history of breathing apparatus and its use, describing types. Discussion. 4500 w. Jour Can Min Inst—1909. No. 15163 N.

Rescue Chambers.

Refuge Chamber in Mines. Plans and description prepared by Jesse J. Johnson and presented in course of a debate on mine rescue work at Washington. Ills. 1000 w. Min & Sci Pr—June 18, 1910. No. 15148.

Testing Stations.

The Liévin Testing Station (La Station d'Essais de Liévin). J. Taffanel. Describes an important station in France for the investigation of the causes of mine explosions. Ills. 6000 w. Mem Soc Ing Civ de France—March, 1910. No. 14811 G.

Washing.

The Mechanical Preparation of Coal. H. H. Stoek. Abstract of a paper read before the Int. Ry. Fuel Assn. Considers the aim in the treatment and methods employed. 5500 w. Min Wld—June 11, 1910. No. 14710.

West Virginia.

Coal Mining at Morgantown, West Virginia. R. B. Brinsmade. Describes the mines, haulage system, methods of mining and related matters. Ills. 1800 w. Eng & Min Jour—June 11, 1910. No. 14700.

COPPER.

Alaska.

The Kennicott Bonanza Copper Mine, Alaska. L. W. Storm. Illustrated description of this mine and facts relating to it. 2500 w. Eng & Min Jour—June 11, 1910. No. 14697.

British Columbia.

The Mineral Resources of the Queen Charlotte Islands. J. McLellan. Describes the extensive mineralization, as yet undeveloped. 3000 w. Qr Bul Can Min Inst—April, 1910. No. 15188 N.

California.

The Occurrence of Copper in Shasta County, California. L. C. Graton. A preliminary statement of the features of the Shasta County copper region and some of the general conclusions reached. Map. 18000 w. U S Geol Surv—Bul. 430-B. No. 14644 N.

The Balaklala Mine and Smelter, California. A. H. Martin. Illustrates and describes these copper mines and their development. 3500 w. Min Wld—June 11, 1910. No. 14708.

Chile.

Copper Mining & Smelting in the District of Los Bronces, Santiago, Chile. J. Blanquier. Information concerning these copper deposits, their mining and treatment. 1200 w. Min Jour—June 4, 1910. No. 14736 A.

Converters.

Copper Converters with Basic Lining. Redick R. Moore. Discusses the operation of basic lined converters, stating the advantages and disadvantages, and considering the Peirce and Smith patent claims. 5000 w. Eng & Min Jour—June 25, 1910. No. 15199.

Idaho.

Geology of the Copper Deposits Near Montpelier, Bear Lake County, Idaho. Hoyt S. Gale. Describes the geology of the copper-bearing rocks, the occurrence, developments, etc., and gives a summary and conclusions. Map. 3000 w. U S Geol Surv—Bul. 430-B. No. 14645 N.

Mexico.

Los Pilares Mine, Nacozari, Mexico. Courtenay De Kalb. Illustrated account of mining methods of interest at this important copper mine. 2500 w. Min & Sci Pr—June 18, 1910. No. 15147.

Montana.

The Corbin District, Jefferson County, Montana. Floyd Bushnell. Mines now developing copper ores were formerly large producers of silver. Ills. 2000 w. Eng & Min Jour—June 4, 1910. No. 14573.

Nevada.

Present Conditions at Ely. Illustrated account of operations at these copper mines, the milling and smelting plants and methods of mining. 1800 w. Min & Sci Pr—June 11, 1910. No. 14974.

Nova Scotia.

Notes on the Copper Lake Mine, Antigonish, N. S. John W. McLeod. History and illustrated description. 2800 w. Jour Can Min Inst—1909. No. 15183 N.

Ontario.

The Mining, Smelting and Power Plants of the Canadian Copper Company. G. E. Silvester. Illustrated detailed description of three plants at Copper Cliff, Ont., for producing nickel. 7500 w. Jour Can Min Inst—1909. No. 15161 N.

Pennsylvania.

The Copper Deposits of South Mountain in Southern Pennsylvania. George W. Stose. The geology, ore deposits, and origin of the ore. Map. 4000 w. U S Geol Surv—Bul. 430-B. No. 14646 N.

Production.

Copper Through Fifty Years. James Douglas. A brief review of the industry since the middle of the last century. 3000 w. Min & Sci Pr—May 21, 1910. No. 14432 C.

Smelter Fumes.

Smeltery Smoke as a Source of Sulphuric Acid. W. H. Freeland and C. W. Renwick. Illustrated description of a plant at Ducktown, Tenn., utilizing blast furnace gas. 2500 w. Eng & Min Jour—May 28, 1910. No. 14425.

Smelting.

Fifty Years of Smelting in the Western States. L. S. Austin. Discusses especially the development of lead and copper smelting and comparisons made with present practice. 2500 w. Min & Sci Pr—May 21, 1910. No. 14438 C.

Some Western Metallurgical Problems. A. W. Warwick. Abstract of a paper read before the West. Assn. of Tech. Chem. & Met. Considers some processes suggested for the treatment of complex sulphide ores, oxidized copper ores, and tailings. 5000 w. Min Wld—June 11, 1910. No. 14709.

GOLD AND SILVER.

Amalgamation.

See Tailings, under Ore Dressing and Concentration.

Arizona.

A Silver Bearing Diorite in Southern Arizona. Josiah Bond. Describes a new occurrence of silver. 1500 w. Eng & Min Jour—June 18, 1910. No. 14983.

The Kingman Mining District of Arizona. Walter Harvey Weed. Descriptive account of the region and its mining properties. 2500 w. Min Wld—June 4, 1910. No. 14586.

Australia.

The Gold Production of Western Australia. John Plummer. Reports a steady decline in production since 1903. 1800 w. Min Wld—June 11, 1910. No. 14711.

Mount-Spencer Gold and Mineral Field. Lionel C. Ball. Illustrated account, with special reference to its copper mines. 4500 w. Queens Gov Min Jour—May 14, 1910. No. 15222 B.

Eungella Goldfield. Lionel C. Ball. Abridged field notes with sketch plan. 5000 w. Queens Gov Min Jour—April 15, 1910. No. 14605 B.

Yerranderie Silver Field, New South Wales. E. F. Pittman. Describes the occurrence of native silver, and reports the nine mines now working. 2000 w. Aust Min Stand—May 4, 1910. No. 14603 B.

The Neglected Ovens District Goldfields (V.). An account of this extensive auriferous region. The present article discusses the production. Map. 3000 w. Aust Min Stand—April 20, 1910. Serial. 1st part. No. 14600 B.

British Columbia.

Mining in Atlin, British Columbia, 1898-1908. Rosalind Watson Young. Reviews the history of the ten years. Ills. 4500 w. Jour Can Min Inst—1909. No. 15173 N.

Recent Mining Developments on the Skeena River. W. W. Leach. An account of prospecting on an area tributary to the projected line of the Grand Trunk Pacific railway. 2000 w. Qr Bul Can Min Inst—April, 1910. No. 15190 N.

The Portland Canal Mining District. R. W. Thomson. Describes a promising mining district of the Pacific Coast. 2000 w. Qr Bul Can Min Inst—April, 1910. No. 15191 N.

Mineral Resources of the "Lardeau," British Columbia. Newton W. Emmens. Treats the subject from an economic standpoint. Deposits of gold, silver, lead and zinc ores are known. Ills. 8800 w. Jour Can Min Inst—1909. No. 15172 N.

Gold Ores of the Lardeau District, B. C. Newton W. Emmens. Illustrated description of quartz veins and their development. 3000 w. Min Wld—June 25, 1910. No. 15214.

California.

Mining on the Mother Lode in Amador County, California. William H. Storins. Interesting review of the history of the Eureka-Badger vein. 3500 w. Min & Sci Pr—June 18, 1910. No. 15150.

Cobalt.

Diabase and Aplite of the Cobalt-Silver Area. N. L. Bowen. Presents results of Chemical and microscopic examination of samples. 3000 w. Jour Can Min Inst—1909. No. 15176 N.

Colorado.

Lessons from Stratton's Independence, Colo. Shows how low-grade dump material was handled at a profit. Ills. 1500 w. Min Wld—June 18, 1910. No. 15005.

Cyaniding.

Proposed Simplification of the Cyanide Process. Bruno Mierisch. Outlines two schemes whereby filtering, fillet-pressing and zinc-box precipitation may be avoided. 1200 w. Eng & Min Jour—June 25, 1910. No. 15201.

Improvements in the Cyanide Process. Bernard MacDonald. Brief review of improvements in the mechanical manipulation of the ore-pulp during treatment, and in methods of recovering the metals. Ills. 2000 w. Min & Sci Pr—May 28, 1910 No. 14539.

Rapid Anaylsis of Commercial Cyanide. Ralston Bell. Explains the process and the calculation, illustrating by examples. 1800 w. Eng & Min Jour—May 28, 1910. No. 14424.

Dredging.

Gold Dredging in British Columbia. Arthur E. Hepburn. Compares conditions with those existing in other countries, indicating the causes for the non-success. Ills. 3000 w. Jour Can Min Inst—1909. No. 15174 N.

• See also Korea, under Gold and Silver.

Electrolytic Refining.

Electrometallurgy at Philadelphia Mint. H. J. Slaker. Illustrates and describes the electrolytic parting and refining of bullion in the U. S. mints. 2500 w. Elec Wld—June 23, 1910. No. 15136.

Korea.

Dredging Possibilities in Korea. R. Y. Hanlon. An illustrated article giving information in regard to the placers and the methods of working. 1200 w. Min & Sci Pr—June 4, 1910. No. 14671.

Madagascar.

The Industrial Development of Madagascar (Madagascar, son Développement industriel). M. Ratel. Discusses particularly the gold-mining industry. Ills. 4500 w. Tech Mod—May, 1910. No. 14825 D.

Mexico.

The Mapimi Mining District, Durango, Mexico. Illustrated description of mines yielding gold, silver and lead. 1600 w. Min Wld—June 25, 1910. No. 15216.

The Mines of the Altar District, Sonora, Mexico. Charles A. Dinsmore. Describes the working of the placers, the ore treatment, and the quartz mines. Ills. 2500 w. Min Wld—May 28, 1910. No. 14427.

Ontario.

First Year of the Gowganda District, Ontario. G. M. Colvocoresses. An illustrated account of the first year of development. 3000 w. Eng & Min Jour—June 11, 1910. No. 14696.

Porcupine Gold Field's Developments to Date. Alex. Gray. Illustrated report of Ontario's latest mining field. 1800 w. Min Wld—June 4, 1910. No. 14589.

The Porcupine Gold Area. W. E. H. Carter. An illustrated account of a recent visit to the district, describing the deposits and conditions. 2000 w. Can Min Jour—June 15, 1910. No. 15000.

See also Sampling, under ORE DRESSING AND CONCENTRATION.

Quebec.

The Chibogomou Region, Province of Quebec. E. Dulieux. Reports concerning the geology, mineral deposits, and the desirabliity of uniting the district by a line of railway. Ills. 3000 w. Jour Can Min Inst—1909. No. 15160 N.

Utah.

Mines and Mill of the Consolidated Mercur Co. Roy Hutchins Allen. Describes the deposits, and the successful cyanidation of complex refractory ores. Ills. 5000 w. Eng & Min Jour—June 18, 1910. No. 14985.

IRON AND STEEL.

Analysis.

The Titration of Permanganate with Arsenic Acid in Neutral or Slightly Alkaline Solutions (Ueber die Titration von Permanganat mit arseniger Säure in neutralen oder schwach alkalischen Lösungen). Eugen Deiss. Reports the results of an extended research. 3700 w. Stahl u Eisen—May 4, 1910. No. 14860 D.

Bessemer.

Sir Henry Bessemer, a Great Inventor (Un grand Inventeur: Sir Henry Bessemer). Henry Le Chatelier. A review and appreciation of Bessemer's work, with lists of his inventions, correspondence, etc. Ills. 15000 w. Rev de Métal—May, 1910. No. 14813 E + F.

Blast-Furnace Practice.

The Agglomeration Process at the Fernie Works, Giessen (Das Agglomerierverfahren auf den Fernie-Werken bei Giessen). Friedrich Witte. Describes a process for consolidating friable iron ore before charging into the blast furnace. Ills. 3000 w. Stahl u Eisen—May 4, 1910. No. 14859 D.

Blast Furnaces.

The New Earlston Furnace. Illustrates and describes features of top construction and of bottom filling in a furnace at Everett, Pa. 1200 w. Ir Age—June 23, 1910. No. 15115.

The Thin-Lined Water-Cooled Blast Furnace. Section and description of a change in construction methods which gives promise of good results. 1400 w. Ir Trd Rev—June 16, 1910. No. 14961.

Blowing Engines.

Gas-Driven Blowing Plant at the Works of Messrs. Vivian & Sons, Swansea. Illustrated description. 2000 w. Ir & Coal Trds Rev—May 27, 1910. No. 14631 A.

China.

Iron and Steel Works at Hanyang, Hupe, China. A. J. Seltzer. Illustrated description of the works and their equipment. 2500 w. Eng & Min Jour—June 11, 1910. No. 14698.

Electrometallurgy.

The Electric Furnace and the Electrometallurgy of Iron and Steel. A. Stansfield. Abstract of a lecture describing types of furnace used. Ills. 1500 w. Jour Can Min Inst—1909. No. 15171 N.

The Electric Furnace in the Iron and Steel Industry. G. Hooghwinkel. Read before the Sheffield Soc. of Engrs. & Met. Gives results obtained with various types of electric furnaces both for smelting and refining work. 4000 w. Elect'n, Lond—June 3, 1910. No. 14730 A.

Tool Steel Direct from the Ore in an Electric Furnace. Alfred Stansfield. Read before the Can. Min. Inst. An account of experimental work in the plant of J. W. Evans. Ills. 2500 w. Can Min Jour—June 15, 1910. No. 15001.

The Electric Steel Furnace (Beitrag zum Studium der Elektrostahlofen). A discussion of hearth materials and construction. Ills. Serial. 1st part. 1000 w. Elektrochem Zeitschr—May, 1910. No. 14856 D.

England.

Cleveland Ironstone and Iron. J. E. Stead. Abstract from a paper read before the Cleveland Inst. of Engrs. Illustrated article describing the microstructure and discussing the genesis, and interesting feature. 5000 w. Ir & Coal Trds Rev—May 20, 1910. No. 14480 A.

Germany.

The Iron-Ore Resources of Germany (Die Eisenerzvorräte des Deutschen Reiches). F. Beyschlag, G. Einecke and W. Köhler. A detailed study of the various districts. Ills. 22000 w. Stahl u Eisen—May 25, 1910. No. 14862 D.

Michigan.

Michigan Iron Mines and Their Mine Waters. Alfred C. Lane. Gives a general description of the ores and the theories of their origin and a study of interesting mine waters. 4500 w. Jour Can Min Inst—1909. No. 15158 N.

Newfoundland.

See Slopes, under MINING.

Ontario.

The Wilbur Iron Mine. Shirley King. Describes the deposit and the geology. 3000 w. Jour Can Min Inst—1909. No. 15179 N.

Open-Hearth Furnaces.

Sunday Rest in Open-Hearth Plants (Die Sonntagsruhe in den Martinwerken). Discusses the effect of suspension of operations on Sunday, with special reference to recent German legislation. 5600 w. Stahl u Eisen—May 4, 1910. No. 14857 D.

Open-Hearth Plants.

The Installation of an Open-Hearth Steel Plant (Installation d'une Aciérie Martin). E. Davin. A brief discussion of the equipment required and its arrangement in the plant. 3000 w. All Indus—May, 1910. No. 14832 D.

Ore Prices.

The Market Price of Different Kinds of Iron Ore. Prof. T. M. L. Vogt. On appendix to the report of the Norwegian Elec. Met. Committee, discussing the factors which determine the price. 2200 w. Ir & Coal Trds Rev—May 27, 1910. No. 14632 A.

Rolling Mills.

New McKeesport Tin Plate Mills. Illustrated account of the remarkably rapid construction of an addition to this plant. 1500 w. Ir Age—June 23, 1910. No. 15118.

Russia.

Some Important Factors in the Russian Iron and Coal Trades. Charles J. Smith. An explanation of the present condition of these industries and the recent changes. 3500 w. Ir & Coal Trds Rev—May 27, 1910. No. 14629 A.

Steel Making.

Putting Carbon into Steel. Philo Kemery. Describes various methods of adding carbon to steel to obtain different grades. 3500 w. Am Mach—Vol. 33. No. 25. No. 15129.

Transvaal.

Report of F. W. Harbord on the Manufacture of Iron and Steel in the Transvaal. Gives report as published by the Government. 3000 w. Engr, Lond—May 27, 1910. Serial. 1st part. No. 14628 A.

LEAD AND ZINC.

Lead Smelting.

Lead and Zinc Smelting in Upper Silesia. O. H. Hahn. A review of 20 years' progress, the development of the Huntington-Heberlein process, and the state-controlled smelteries. 3500 w. Eng & Min Jour—May 28, 1910. No. 14423.

Early Smelting at Cerro Gordo. Francis Drake. An account of early smelting of the silver-lead ores, and the waste because of methods used. 1500 w. Min & Sci Pr—May 21, 1910. No. 14437 C.

See also Smelting, under COPPER.

Missouri.

Mining on a Royalty Basis. Lucius L. Wittich. Illustrated article discussing methods and cost of mining in the Joplin district. 4500 w. Mines & Min—June, 1910. No. 14560 C.

Wisconsin.

Empire-Enterprise Zinc Mines, Wisconsin. Harold C. George. Gives the geology, history, and mining equipment and methods. Ills. 2000 w. Eng & Min Jour—June 18, 1910. No. 14987.

Zinc Smelting.

See Lead Smelting, under LEAD AND ZINC.

MINOR MINERALS.

Antimony.

The Wheaton River Antimony Deposits, Yukon Territory. D. D. Cairnes. Describes these recently discovered deposits. Ills. 4000 w. Qr Bul Can Min Inst—April, 1910. No. 15189 N.

Arsenic.

Arsenic Manufacture at Midvale, Utah. Leroy A. Palmer. Illustrated description of a plant for roasting arsenic ores and condensing and refining the fume. 3300 w. Mines & Min—June, 1910. No. 14555 C.

Asbestos.

Notes on Recent Developments in Asbestos Mining in Quebec. W. J. Woolsey. Describes geological features, mining and milling methods. Ills. 1500 w. Qr Bul Can Min Inst—April, 1910. No. 15192 N.

Notes on the King Bros.' Asbestos Mine, Thetford, Quebec. Ezra B. Rider. Gives the topography, geology, history and statistics, with description. Ills. 4000 w. Jour Can Min Inst—1909. No. 15182 N.

Cement.

Combustion in Cement-Burning. Byron E. Eldred. A critical study of the present practice of burning cement, and suggesting the use of a gas-fired rotary kiln. 4500 w. Bul Am Inst of Min Engrs—June, 1910. No. 15094 F.

See also same title, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Chromite.

Chrome Bearing Peridotites of Lake

Abitibi. H. T. White. Describes the chromite ore bodies. 1600 w. Jour Can Min Inst—1909. No. 15180 N.

Clays.

The Geological Investigation of Clays. Heinrich Ries. Remarks on the importance of this material, its uses, value, and the methods of geological investigation. 1800 w. Jour Can Min Inst—1909. No. 15166 N.

Prospecting and Testing of Clay Deposits. E. K. Soper. Information concerning their distribution and value, method of testing, etc. 3500 w. Min & Sci Pr —June 4, 1910. No. 14670.

Diamonds.

Prospecting for "Black Diamonds." A. S. Atkinson. Describes conditions and methods of mining in Bahia, Brazil, the only place where they occur. 2200 w. Mines & Min—June, 1910. No. 14556 C.

Fireclay.

The Mining and Fabrication of Fireclay. A. S. B. Little. An illustrated article aiming to arouse the interest of engineers and manufacturers in the improvement of this industry. 3500 w. Engineering Magazine—July, 1910. No. 15260 B.

Lithium.

Lithium and Its Sources. Frank L. Hess. Information concerning this alkaline metal—the lightest known solid element. Ills. 2200 w. Min & Sci Pr—June 4, 1910. No. 14669.

Natural Gas.

See Oil, under Minor Minerals.

Nickel.

See Ontario, under Copper.

Oil.

A Rapid Method for the Indentification of Gas Oils. F. E. Park and L. E. Worthing. Read before the Am. Gas Inst. Reviews briefly the chemical composition of petroleum, and describes a process of bromination. Short discussion. 3500 w. Pro Age—June 1, 1910. No. 14412.

The Conditions of Accumulation of Petroleum in the Earth. David T. Day. A summary of information obtained upon the variations in color and specific gravity as found in different places, and also variations in chemical composition. 2000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15096 F.

The Use of Geological Science in the Petroleum and Natural Gas Business. Frederick G. Clapp. An explanation showing geology to be of great value to the oil and gas operator. Ills. General discussion. 10500 w. Pro Engrs' Soc of W Penn—May, 1910. No. 15046 D.

The California Oil Industry. Courtenay De Kalb. Abstract of an address at meeting of the California Development Board. Remarks on the wonderful development, describing the oil fields, and giving much information. 3500 w. Min & Sci Pr—June 11, 1910. No. 14971.

Significance of Oil Refining in Louisiana. David T. Day. First of a series of articles on the oil and gas development of Louisiana and Texas. Ills. 5000 w. Mfrs' Rec—June 23, 1910. Serial. 1st part. No. 15108.

Developments of a New Texas Oil Field. Charles A. Dinsmore. Brief account of the development of the property of the Producers' Oil Co. at Toyah, Texas. 1500 w. Min Wld—June 4, 1910. No. 14588.

The Oil Excitement in Mexico. H. S. Denny. Gives information gathered during a recent tour of inspection dicussing the controversy of the Pearson and Waters-Pierce companies. 4000 w. Min Jour—June 4, 1910. No. 14737 A.

Russian Petroleum. Reviews the conditions in the old oil fields, the new discoveries, and the production. 2500 w. Mines & Min—June, 1910. No. 14558 C.

The Oilfields of New Zealand. Maps and descriptions of the districts. 1600 w. Min Jour—June 11, 1910. Serial. 1st part. No. 15035 A.

Leinweber Method of Extracting Oil from Wells. Frederick A. Talbot. The main feature is an endless cable carrying absorbent material, which delivers 7 oz. of oil per foot of cable. Ills. 1200 w. Eng & Min Jour—June 18, 1910. No. 14984.

Phosphates.

Guano and Phosphate Deposits of the Pacific Ocean (Les Gisements de Guano et de Phosphates de l'Océan Pacifique). Paul Privat-Deschanel. Discusses their location, extent, exploitation, origin, etc. 3200 w. Génie Civil—May 21, 1910. No. 14841 D.

Plaster of Paris.

A Comparative Study of the Classic Kiln Method of Making Plaster of Paris and the Périn Process (Etude comparée sur le Procédé classique de Fabrication du Plâtre dit des "Fours culées" et le Procédé Périn). L. Périn. Ills. 6000 w. Mem Soc Ing Civ de France—March, 1910. No. 14812 G.

Precious Stones.

Some Ancient Ideas Regarding Gems. Gordon Surr. Information from the work on "Gems and Gem Minerals" by O. C. Farrington. 2500 w. Min Wld—June 25, 1910. No. 15215.

Rare Earths.

The Rare Earths and Incandescent Lighting (Les Terres rares et l'Eclairage à l'Incandescence). Capt. Nicolardot. Discusses their discovery, properties, mining, and application in the manufacture of incandescent gas mantles, describing the processes and various types of gas lamp. Ills. 12500 w. Bul Soc d Encour—April, 1910. No. 14816 G.

Salt.

New Salt Works in Cheshire. Brief illustrated description of works at Weston

Point, and improvements at Winsford. 1500 w. Engr, Lond—June 10, 1910. No. 15038 A.

Statistics of the Alpine Salt Industry (Statistische Mitteilungen über den Betrieb der alpinen Salinen). Anton Schnable. A review of the industry since 1950. 5000 w. Oest Zeitschr f Berg u Hüttenwesen—May 14, 1910. No. 14866 D.

Structural Materials.

Field Investigations of Structural Materials by the U. S. Geological Survey. Ernest F. Burchard. Gives account of the work, explaining its aims. 1500 w. Bul Am Inst of Min Engrs—June, 1910. No. 15098 F.

Tin.

Fifty Years in Cornwall. Thomas Rickard. Brief review of improvements introduced in drainage, dressing methods, etc., and remarks on needed improvements and the present conditions. 3000 w. Min & Sci Pr—May 28, 1910. No. 14538.

Reminiscence of Mining in Cornwall. Joseph Vivian. An account of the mining of copper and of tin and the history of the mines. 2500 w. Min & Sci Pr—May 21, 1910. 14436 C.

Tourmaline.

Tourmaline in California. John L. Cowan. Information in regard to the deposits and their value. 2200 w. Min & Sci Pr—June 11, 1910. No. 14973.

Tungsten.

Ductile Tungsten. W. D. Coolidge. Outlines the difficulties met in the mechanical working of tungsten, and the final success. 1800 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14059 F.

MINING.

Accidents.

Mining Accidents and the Rendering of First Aid. Charles H. Hair. Brief consideration of avoidable and unavoidable accidents and directions for first aid. 2000 w. Jour Can Min Inst—1909. No. 15165 N.

Mine Accidents. E. T. Corkill. A study of the causes and the prevention. Discussion. Ills. 6000 w. Jour Can Min Inst—1909. No. 15164 N.

Accounting.

Mine Accounting (Kaufmännische und kameralistische Buchfuhrung fur Bergwerke). Herr Witte. A complete scheme for a set of mine accounts. Ills. 7000 w. Gluckauf—May 7, 1910. No. 14870 D.

Ankylostomiasis.

Ankylostomiasis in Austria and Combative Measures (Die Wurmkrankheit—Ankylostomiasis—in Oesterreich und ihre Bekämpfung). Arpad Kriz. Discusses the extent of the disease and methods of prevention. 2000 w. Oest Zeitschr f Berg u Huttenwesen—May 7, 1910. No. 14864 D.

Bore Holes.

Measurements of the Increase of Temperature in Bore-Holes with the Depth; the Technics and Practical Importance of Same for Geological Prognosis. Joh. Koenigsberger and M. Muhlberg. Read before the Inst. of Min. Engrs. Explains method of measurements, giving conclusions and results. 3500 w. Ir & Coal Trds Rev.—June 3, 1910. No. 14761 A.

Boring.

Use of the Terry Core Drill in Mine Operations. Cores 30-inches in diameter have been obtained. A number of 20-inch bore holes are being sunk at Hermon, N. Y. Gives advantages, cost, etc. Ills. 1800 w. Eng & Min Jour—June 4, 1910. No. 14574.

Diamond Drilling.

Drill Core Problems. Alfred C. Lane. Explains a method of calculating the positions of strata from indications on cores. 1500 w. Mines & Min—June, 1910. No. 14561 C.

Drills.

History of the Rock Drill. W. L. Saunders. An account of its invention and development. 1200 w. Min & Sci Pr—May 21, 1910. No. 14433 C.

The Wolski Hydraulic Rock Drill. F. A. Talbot. Describes a drill which utilizes the water hammer effect when a moving column of water is suddenly stopped. 1800 w. Eng & Min Jour—June 18, 1910. No. 14986.

Electric Hoisting.

Electrically Driven Winding Engine. An extensive electrical installation at the Harton Colliery, England, is illustrated and described. 1200 w. Engr, Lond—June 17, 1910. No. 15244 A.

Electric Power.

Application of Electricity in Mines in Europe. R. Nelson. Explains grounds for preferring 3-phase alternating current, discussing the requirements for safety. 2800 w. Min Wld—June 25, 1910. No. 15218.

Erection and Maintenance of Electrical Plant on a Gold Mine. W. Elsdon Dew. Deals with various phases of practical work on a gold mine. 2000 w. Elec Engr, Lond—May 20, 1910. No. 14445 A.

Gas Power.

Some Notes on Gas Power and Its Applicability to Mining. A. Burnett. Remarks on the status of the gas engine, outlining the philosophy of the gas producers. Discussion. 5000 w. Jour Can Min Inst—1909. No. 15162 N.

Haulage.

The Evolution of Mine Haulage. An illustrated review of means of transporting ore in various parts of the world. 4000 w. Mines & Min—June, 1910. No 14563 C.

See also Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Head Frames.

Types of Head Frames on the Mother Lode. William H. Storms. Illustrations with short descriptions. 1500 w. Min Wld—June 18, 1910. No. 15002.

Hoisting.

Frictional Resistances in Hoisting Plants (Reibungswiderstände bei Förderanlagen). J. Havlicek. Reports tests on an Ilgner plant. Ills. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—May 21, 1910. No. 14867 D.

Hoisting Cages.

Intermediate Gears on Hoisting Cages (Die Auswechselung der Zwischengeschirre an Förderkörben). Herr Busse. Discusses materials and design for safe construction. 3000 w. Glückauf—May 21, 1910. No. 14874 D.

Law.

Deficiencies in Canadian Mining Laws. H. Mortimer Lamb. Read before the Can. Min. Inst. Critical discussion of some existing regulations. 3000 w. Min Wld—June 18, 1910. No. 15006.

Some Notes on the Mining Laws of Ontario. J. Lorn McDougall. Discussion. 4000 w. Jour Can Min Inst—1909. No. 15169 N.

Seventy Years of Mining Legislation. G. W. Chrystall. From the Second Report of the Royal Commission on Mines. A review. 7500 w. Ir & Coal Trds Rev—May 20, 1910. No. 14481 A.

The Law of Mineral Rights in Germany (Die rechtmässige Gewinnung bergfreier und fremder Mineralien). Herr Lohmann. A discussion of certain important points. Ills. Serial. 1st part. 10500 w. Glückauf—May 21, 1910. No. 14875 D.

Mine Cars.

The Summers Motor Driven Ore Car. Brief illustrated description of a car built for the Int. Smelting & Refining Co. 500 w. Ir Age—June 9, 1910. No. 14651.

Mine Locomotives.

Electric Tramming at Iron Mines. Illustrated description of the single-motor locomotive used for tramming in the deep iron mines of the Lake Superior ranges. 1200 w. Ir Age—June 2, 1910. No. 14484.

Mine Telephones.

Telephone Practice in Mines and on Railways. Illustrated description of a system for transmitting instructions from the surface to underground works. 3500 w. Elec Engr, Lond—May 20, 1910. No. 14444 A.

Mine Waters.

See Michigan, under IRON AND STEEL.

Prospecting.

Some Ideas Prevalent Among Prospectors. Gordon Surr. Considers notions more or less common. 1700 w. Min Wld—June 18, 1910. No. 15004.

Sanitation.

The Sanitation of Mines in Respect to Human Dejecta. Henry Kenwood. From a paper in the *Trans. of the Roy. Inst. of Pub. Health.* Explains the danger from polluted dust and considers means to prevent contamination. 2500 w. Col Guard—May 27, 1910. No. 14616 A.

Shafts.

The Giroux Shaft at Kimberly, Nevada. C. Everard Arnold. Describes the five-compartment shaft and its construction. Ills. 800 w. Eng & Min Jour—June 25, 1910. No. 15200.

The Giroux Shaft at Kimberly, Nev. C. Everard Arnold. Illustrated description of the five-compartment shaft which will serve the Alpha mine. 1000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15095 F.

The Best Form of Shaft Tubbing (Ueber die zweckmässigste Tübbingform). L. Maduschka. Criticises Herr Heise's article in *Glückauf*, with correspondence between the two authors. Ills. 4000 w. Glückauf—May 7, 1910. No. 14871 D.

Shaft-sinking.

Sinking the Woodward No. 3 Shaft. R. V. Norris. Illustrates and describes unusual methods required to sink through gravel and quicksand saturated with water. 3500 w. Eng & Min Jour—June 4, 1910. No. 14580.

The Sinking of the Astley Green Shafts at Astley, near Manchester, by Means of the Drop-Shaft Method and Under-Hanging Tubbing. Charles Pilkington and Percy Lee Wood. Abstract of a paper read before the Manchester Geol. & Min. Soc. Illustrated detailed description of the work. 3000 w. Ir & Coal Trds Rev—June 17, 1910. No. 15248 A.

The Sinking and Equipment of the Littleton Collieries. T. H. Bailey. Describes the geological features, early operations, unwatering and sinking, equipment and plant. Ills. 9500 w. Col Guard—June 17, 1910. No. 15234 A.

The Sinking and Equipment of the Littleton Collieries. Thomas Henry Bailey. Abstract of paper read before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Illustrated description of the unwatering and sinking, and the surface equipment and plant. 4500 w. Ir & Coal Trds Rev—June 10, 1910. No. 15039 A.

Slopes.

The Sinking of the Wabana Submarine Slopes. An account of the development of under-sea deposits of iron ore in Newfoundland. 3000 w. Jour Can Min Inst—1909. No. 15159 N.

Surveying.

Modern Method of Plumbing a Shaft. John P. Davis. Gives details of the system employed in the anthracite fields, where steel wires are preferred to copper, and the plummets immersed in an oil bath. Ills. 1200 w. Eng & Min Jour—June 4, 1910. No. 14578.

Taxation.

The Probable Effect of the Acreage Tax on Mining Lands in Ontario. G. R. Mickle. A forecast. Discussion. 9000 w. Jour Can Min Inst—1909. No. 15168 N.

Unwatering.

Reclaiming Flooded Drift Mines in Alaska. W. H. Lanagan. Describes three different methods put in practice in the Nome district. Ills. 3000 w. Min & Sci Pr—June 18, 1910. No. 15149.

Valuation.

Mine Valuation (Wertschätzung von Bergwerken). A review of a book on this subject by W. Kreutz. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—May 14 1910. No. 14865 D.

Ventilation.

Proportining Fans to Mines. Thomas W. Fitch, Jr., and J. R. McColl. Illustrates and describes methods of locating fans at shafts and drifts to avoid damage in case of explosion. 1800 w. Mines & Min—June, 1910. No. 14566 C.

ORE DRESSING AND CONCENTRATION.

Concentration.

Calculation of Recovery in Concentration. Theodore J. Hoover. Gives formulae believed to be sound in theory, discussing the possible errors. 1500 w. Eng Min Jour—June 11, 1910. No. 14699.

Filter Presses.

See Slimes Treatment, under Ore Dressing and Concentration.

Flocculation.

The Phenomena of Flocculation and Deflocculation. E. E. Free. Outlines the present knowledge of these phenomena as they affect suspension and as they are affected by various external conditions. Ills. 4500 w. Jour Fr Inst—June, 1910. Serial. 1st part. No. 14920 D.

Gold Milling.

The Metallurgy of Gold. Donald Clark. Describes in detail the Edwards' Pyrites Works. Bendigo (V.). 2500 w. Aust Min Stand—April 27, 1910. No. 14601 B.

Treatment of Concentrates at Kalgoorlie, Western Australia. W. M. von Bernewitz. Gives an outline of the process in vogue at the present time. 1800 w. Min Jour—May 21, 1910. No. 14452 A.

Iron.

The Trout Lake Concentrating Mill. J. N. Roherty. Illustrates and describes the concentrating plant at Coleraine, Minn. 1500 w. Wis Engr—June, 1910. No. 14930 D.

Roasting.

Recent Progress in Blast-Roasting. Prof. H. O. Hofman. A review of the present practice of blast-roasting in the United States and Canada, citing characteristic examples. Ills. 8000 w. Bul Am Inst of Min Engrs—June, 1910. No. 15097 F.

Blast and Down Draft Sintering. Redick R. Moore. Discusses the proper name for processes of desulphurization and agglomeration of fine sulphide ores. 1000 w. Met & Chem Engng—June, 1910. No. 14634 C.

Roasting of Ore, Concentrates, Slimes, Etc. J. E. Edwards. Abstract of a paper read before the W. Assn. of Chem. & Met. Explains the object of roasting, the chemistry, discussing furnace design. treatment, etc. 4000 w. Aust Min Stand—May 11, & 18, 1910. 2 parts. 15221 each B.

Sampling.

I. A Suggestion on "Quartering-Down" Large Samples. II. A Note on the Sampling of the Porcupine Ore Bodies. III. Some Notes on the Philosophy of Sampling. Three articles by H. E. T. Haultain, giving personal opinions of the Porcupine gold district. Ills. 4000 w. Can Min Jour—June 15, 1910. No. 14999.

Screen Analysis.

A Standard Series of Screens for Laboratory Testing. Theodore J. Hoover. Suggestions for a system of measurement of the qualitative result of the operation of grinding ore, and presents a mechanical method of making screen anaylses. Ills. 4000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14917 N.

Grading Analyses and Their Application. H. Stadler. Notes showing how proportions of certain standard sizes of particles produced in grinding may be valued in units of energy. 3000 w. Inst of Min & Met, Bul 68—May 19, 1910. No. 14918 N.

Silver Milling.

The Washoe Process. A. D. Hodges, Jr. Gives briefly facts relating to its origin and development. 1500 w. Min & Sci Pr—May 21, 1910. No. 14439 C.

Slimes Treatment.

The Treatment of Accumlated Slime, and the Use of Filter Presses for Clarifying Slime Solution and By-Products. John D. O'Hara. Gives experiences in treating accumulated slime by filter presses, compared with the decantation and the Adair-Usher processes. 2000 w. Jour Chem, Met & Min Soc of S Africa—April. 1910. No. 14724 E.

Stamp Mills.

The California Stamp-Mill. Courtenay De Kalb. An illustrated article describing the early mills and their rapid improvement. 2000 w. Min & Sci Pr—May 21, 1910. No. 14434 C.

Tailings.

Values in Dredge and Placer Tailings. Elmer Ellsworth Carey. Remarks on methods of estimating, and the recovery of cost values. 1500 w. Min Wld—June 18, 1910. No. 15003.

MISCELLANY.

Bureau of Mines.

The U. S. Bureau of Mines. Editorial. A critical discussion of its purpose, powers, and influence. 1200 w. Engineering Magazine—July, 1910. No. 15265 B.

Chili.

Mining and Metallurgy in Chili. F. A. Sundt. Information concerning the mineral resources of the country. Map. 2700 w. Mines & Min—June, 1910. No. 14557 C.

Forestry.

The Relation of Mining to Forestry. B. E. Fernow. Urges that an effort be made to prevent needless damage to forests. 2000 w. Jour Can Min Inst—1909. No. 15167 N.

Geological Surveys.

The United States Geological Survey. Robert H. Chapman. Illustrated account of the work undertaken. 7500 w. Qr Bul Can Min Inst—April, 1910. No. 15185 N.

Economic Geology in the United States. Samuel Franklin Emmons. Discusses the early development of mining and the U. S. Government geological work. 5000 w. Jour Can Min Inst—1909. No. 15157 N.

Work of State Geological Surveys. H. Foster Bain. An illustrated article explaining the work and methods. 2500 w. Qr Bul Can Min Inst—April, 1910. No. 15184 N.

Japan.

Metal-Working in Japan. Abstract of a lecture by Prof. W. Gowland, before the Inst. of Metals, on the "Art of Working Metals as Practiced in Old Japan." 3000 w. Engng—May 27, 1910. No. 14621 A.

Mineral Claims.

Wanted—An Inventory of Promising Mineral Claims. R. W. Brock. Explains the advantages of having reliable information and outlines a scheme for recording properties. Discussion. 2500 w. Jour Can Min Inst—1909. No. 15175 N.

Ore Deposits.

Theories of Ore Genesis of Fifty Years ago. S. F. Emmons. An interesting review of the early theories relating to deposits of the precious metals, and the work of the men who advanced them. 5000 w. Min & Sci Pr—May 21, 1910. No. 14435 C.

Genesis of Ores. Joseph Le Conte. Reprinted from this publication's issue of Jan. 24, 1871. 1500 w. Min & Sci Pr—June 4, 1910. No. 14672.

Geochemistry. George Holloway. Discusses the relation between the mineral and the chemical industries. 4000 w. Mines & Min—June, 1910. Serial. 1st part. No. 14559 C.

Notes on the Occurrence of the Ore Body at the City of Cobalt Mine. Frank D. Adams. Also short discussion. 1200 w. Jour Can Min Inst—1909. No. 15170 N.

The Origin of Laterite. J. Morrow Campbell. Information concerning the laterite formation in Africa, its relation to the rocks it covers, its origin, its relation to gold, etc. Ills. 4500 w. Inst of Min & Met. Bul. 67—April 14, 1910. No. 14353 N.

Criteria of Downward Sulphide Enrichment. F. L. Ransome. A critical examination of the lines of evidence by means of which the question whether or not the process has been operative in any given case may be answered. 5000 w. Ec-Geol—April, 1910. No. 14311 D.

Refractory Materials.

Defects in Refractory Brick and Their Causes. Gilbert Rigg. Considers in detail the properties refractory products should possess, and the principal defects. 1800 w. Met & Chem Engng—May, 1910. No. 13690 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

The Principles Governing the Arrangement of Automatic Block Signals. W. H. Arkenburgh. Considers the physical characteristics of a road and their relation to signal locations, and the relation of signals to each other. 4500 w. Ry Age Gaz—June 10, 1910. No. 14684.

The World Signal. J. H. Wisner, Jr. Read before the Ry. Sig. Assn. Illustrates and describes this system and explains its advantages. 1000 w. Ry & Engng Rev—June 18, 1910. No. 15009.

Progress in Interlocking Devices (Note sur les Progrès realisés dans l'Etablissement des Enclenchements). Pierre Lefort. A general review of interlocking problems and of the more important systems. Ills. 22000 w. Ann d Ponts et Chaussées—1910—II. No. 14802 E + F.

Train Staff.

Some Improvements to the Webb and Thompson Train Staff (Ueber einige Verbesserungen des elektrischen Zugstabes von Webb.& Thompson). A. Tobler. Describes recent developments. Ills. 1800 w. Schweiz Bau—May 14, 1910. No. 14884 B.

MOTIVE POWER AND EQUIPMENT.

Continuous Propulsion.

Continuous Propulsion for Railway Trains (Les Trains automobiles à Propulsion continue). A. Doniol. Proposes a system in which the power of the locomotive is transmitted mechanically to the axles of the individual cars. Ills. 8000 w. Rev Gen d Chemins de Fer—May, 1910. No. 14819 G.

Electrification.

Present Status and Tendencies of Railroad Electrification in America. F. Darlington. Gives a short review of old and new electric railroad systems comparing their first cost and efficiency. General discussion. 5000 w. Pro Cent Ry Club—May 13, 1910. No. 15100 C.

Freight Cars.

Steel Frame Box Cars. Illustrated description of cars in service on the Canadian Pacific Ry. 600 w. Am Engr & R R Jour—June, 1910. No. 14703 C.

Locomotive Bearings.

Removable Driving Box Bearing. Illustrated description, with report of results obtained and the advantages of the device. 1000 w. Ry Age Gaz—June 3, 1910. No. 14546.

Locomotive Boilers.

Report for France, Belgium, Italy, Spain and Portugal on the Question of Improvements in Locomotive Boilers. C. Dassesse. Deals with water-tubes, superheaters, valve gear and feed water heaters. Ills. 28000 w. Bul Int Ry Cong—May, 1910. No. 15267 G.

Report (No. 7) for Russia on the Question of Improvements in Locomotive Boilers. G. Noltein. Discusses water-tubes, superheating, valve gear, superheated steam and feed water. Ills. 40000 w. Bul Int Ry Cong—May, 1910. No. 15271 G.

Report for Russia, on the Question of Improvements in Locomotive Boilers. N. Antochine. Discusses the construction and maintaining tubes and tube plates, damages to boilers and their prevention, purification and treatment of boiler waters. Ills. 10000 w. Bul Int Ry Cong—May, 1910. No. 15266 G.

Inequality of Expansion in Locomotive Boilers and the Possibility of Eliminating the Bad Effects Therefrom. D. R. Mac Bain. Illustrations and discussion. 6800 w. Pro N Y R R Club—May 20, 1910. No. 14768.

Locomotive Construction.

The Roumanian Locomotive Competition. Presents the Belgian view of the recent competition instituted by Roumanian State Railway authorities for the delivery of 80 locomotives. 900 w. Engr, Lond—June 17, 1910. No. 15245 A.

Locomotive Explosions.

The Bertry Locomotive Explosion (Note sur l'Explosion de Locomotive de Bertry). M. Anglès-Dauriac. Describes the locomotive, its service, and the explosion, offering conclusions as to its cause. Ills. 5000 w. Ann d Ponts et Chaussées—1910—II. No. 14805 E + F.

Locomotive Fuels.

International Railway Fuel Association. Abstract of the report of S. L. Yerkes on "The Character of the Membership That Should Be Encouraged in the Association," and of other reports. 7000 w. Ry Age Gaz—May 27, 1910. No. 14490.

Locomotive Headlights.

Locomotive Headlights. C. H. Benjamin. An account of experiments made, discussing the results and pointing out the conclusions. General discussion. 14000 w. Pro W Ry Club—April 18, 1910. No. 14769 C.

Locomotives.

Mallet Articulated Compound Locomotive for the Delaware & Hudson Co. Illustrated detailed description and information concerning these powerful engines for pusher service on heavy grades. 5000 w. Ry Age Gaz—May 27, 1910. No. 14491.

Delaware & Hudson Articulated Compound Locomotives. Illustrated detailed description of these powerful engines for pusher service on grades. 3000 w. Mach, (Ry Ed)—June, 1910. No. 14718 C.

Very Powerful Articulated Compound Locomotive. Illustrated description of a design from which six locomotives for the D. & H. Co. have been built to operate on a grade between Carbondale and Ararat, Pa., where curves are numerous. 2500 w. Am Engr & R R Jour—June, 1910. No. 14702 C.

Northern Pacific Mallet Articulated Locomotives. Illustrated detailed description. 1200 w. Mach, (Ry Ed)—June, 1910. No. 14719 C.

Heavy Articulated Locomotives. A powerful Mallet Locomotive for the Northern Pacific is illustrated and described. 800 w. Am Engr & R R Jour—June, 1910. No. 14705 C.

Hybrid Mallet Units for the Erie and the Chicago Great Western Railroads. Diagrams and description of this plan for increasing the power of existing locomotives. 1200 w. Ry & Engng Rev—June 18, 1910. No. 15008.

Pacific Type Engine for the Chicago, Burlington & Quincy. Illustrated description of a heavy 4-6-2 engine equipped with superheater. 1000 w. Ry & Loc Engng—June, 1910. No. 14585 C.

A Metre-Gauge Compound Locomotive with Two Unequal Cylinders and Six Coupled Wheels (Locomotive tender compound à deux Cylindres inégaux et six Roues couplées pour Voie d'un Métre). R. Séguéla. Illustrated description. 1500 w. Rev Gen d Chemins de Fer —May, 1910. No. 14820 G.

See also same title, under STREET AND ELECTRIC RAILWAYS.

Locomotive Spark Arresters.

Sparking in Locomotives and Means of Prevention (Der Funkenwurf der Lokomotiven und die Mittel zu dessen Verhütung). Hermann Liechty. Discusses the causes of spark production and describes a number of locomotive spark arresters. Ills. 4000 w. Glasers Ann—May 15, 1910. No. 14891 D.

Locomotive Stokers.

The Successful Locomotive Mechanical Stoker: Pennsylvania Lines West of Pittsburgh. Outlines the requirements of a locomotive stoker, explaining the weak points in stokers generally, and giving a detailed description of the Crawford stoker which is pronounced successful.

Ills. 6000 w. Ry Age Gaz—June 10, 1910. No. 14682.

Locomotive Superheating.

I. Tests of a Locomotive Using Superheated Steam; Atchison, Topeka & Santa Fe Railway. II. Steam Superheaters for Locomotives; Atchison, Topeka & Santa Fe Ry. H. B. McFarland. Abstract of a report reviewing the question of superheating and its development and giving particulars of comparative tests of engines with and without superheaters. Also editorial. Ills. 8500 w. Eng News—June 21, 1910. No. 14512.

Tests of Jacobs Superheater on a Tandem Compound Santa Fe Type Locomotive. A report of comparative tests made of an engine fitted with Jacobs superheater and reheater and an identical locomotive using saturated steam. Ills. 6500 w. Am Engr & R R Jour—June, 1910. No. 14707 C.

Superheaters. From the report on superheater tests issued by the motive power department of the A., T. & S. F. Ry. Ills. 4000 w. Ry & Engng Rev—June 25, 1910. No. 15219.

Locomotive Tests.

Front End Tests. Gives results of a series of tests to determine the best arrangement of front ends for Pennsylvania Atlantic type locomotives, Classes E2a and E3a. Diagrams. 500 w. Am Engr & R R Jour—June, 1910. No. 14706 C.

Locomotive Wheels.

Test of Locomotive Driving Wheels. E. L. Hancock. Illustrates and describes tests made in a Riehle testing machine of the deformation. 1500 w. Am Engr & R R Jour—June, 1910. No. 14704 C.

Motor Cars.

Benzol-Electric Motor Cars (Benzol-elektrische Triebwagen). Hr. Beyer. Describes new cars of the Prussian State Railways. 2500 w. Zeitschr d Ver Deutscher Ing—May 28, 1910. No. 15079 D.

Shops.

Railroad Shop Layouts. F. Kingsley. A discussion of the features that influence the relative location of the structures that make up an average railroad shop plant. 2500 w. Am Engr & R R Jour—June, 1910. No. 14701 C.

Organization of a Locomotive Repair Shop. J. B. Talmage. Describes the organization of the shops at Collinwood, Ohio, and considers some of the work accomplished. Ills. 2500 w. Yale Sci M—June, 1910. No. 14774 C.

The Installation of Flexible Staybolts. M. M. McAllister. Describes methods at the Collinwood shops of the L. S. & M. S. R. R. 1200 w. Boiler Maker—June, 1910. No. 15121.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrates and describes the erection practice in the Juniata shops. 7000 w. Mach, (Ry Ed.)—June, 1910. No. 14717 C.

A Locomotive Rebuilt in 24 Hours. From the *Erie R. R. Emp. Mag.* Descriptive account of the work. 3800 w. Ry Age Gaz—June 3, 1910. No. 14545.

Car Repair Shop Notes from the Delaware, Lackawanna & Western at East Buffalo. Roy V. Wright. Illustrated description of shops, equipment, methods, etc. 3000 w. Ry Age Gaz—June 3, 1910. No. 14544.

Economy in Turning Wheels (Zur Wirtschaft des Radabdrehens). Herr Krause. Discusses the requirements in wheel-turning lathes and gives some figures of time and power requirements in actual practice. 2000 w. Glasers Ann—May 15, 1910. No. 14893 D.

Central Argentine Railway Workshops Electrification. Illustrates and describes the works at Rossario de Santa Fé. 1500 w. Engr, Lond—May 27, 1910. No. 14625 A.

See also Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Sleeping Cars.

The New Steel Sleeping Cars Built by the Pullman Co. Illustrated description. 1000 w. Ry & Engng Rev—June 11, 1910. No. 14712.

Train Lighting.

The Brown, Boveri & Cie. Electric Train Lighting System (Die elektrische Zugsbeleuchtung System Brown, Boveri & Cie.). Illustrated description of the apparatus and its arrangement. 3000 w. Elektrotechniker—May 25, 1910. No. 15057 D.

Train Resistance.

Freight Train Resistance and Its Relation to Average Car Weight. Edward C. Schmidt. Read before the Am. Ry. Mas. Mech. Assn. A report of tests, describing methods employed in the experiments. 6500 w. Ry & Engng Rev—June 25, 1910. No. 15220.

Wrecking Cranes.

20-Ton Steam Breakdown Crane. Illustrated description of a crane built for coupling to railway-stock and traveling with fast trains, and fitted with vacuum and hand brakes. 300 w. Engng—May 20, 1910. No. 14467 A.

PERMANENT WAY AND BUILDINGS.

Coaling Towers.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Curves.

Relining Compound Curves. W. H. Wilms. Describes a method devised by W. R. Hillary, and found effective. 700 w. Ry Age Gaz—June 17, 1910. No. 14977.

Curve Easements; Present Practices. A summary of replies to questions showing the progress made in the United States, and the advantages. 3500 w. Ry Age Gaz—June 17, 1910. No. 14976.

Elevated Railways.

See same title, under STREET AND ELECTRIC RAILWAYS.

Landslides.

Remedies for Landslides and Slips on the Kanawha and Michigan Railway. R. P. Black. Describes the conditions in West Virginia, explaining the causes of slips and the remedies. 2000 w. Pro Am Soc of Civ Engrs—May, 1910. No. 14940 E.

Rail Joints.

Report for Austria, Roumania, Bulgaria, Servia, Turkey and Egypt, on the Question of Rail-Joints. Friedrich Kramer. Considers reduction in number of joints by lengthening rails, welding, etc. Ills. 22000 w. Bul Int Ry Cong—May, 1910. No. 15269 G.

Stations.

Report for America on the Question of Large Stations. H. A. Jaggard. Considers track arrangements, appliances for handling goods, etc. Ills. 12700 w. Bul Int Ry Cong—May, 1910. No. 15270 G.

Terminals.

The Design of Terminals for Mechanical Freight Handling. H. McL. Harding. Suggestions, indicating the general principles of such designs. 4000 w. Eng Rec—May 28, 1910. No. 14422.

The Terminal Controversy at St. Louis. Samuel O. Dunn. An explanation of the situation at St. Louis, discussing points and merits of the controversy. 7000 w. Ry Age Gaz—June 24, 1910. No. 15153.

The New Chicago Station of the Chicago & North-Western Ry. Illustrated detailed description of a passenger terminal and approaches. 2500 w. Eng Rec—June 18, 1910. No. 14990.

The Winnipeg Railway Terminal Elevated Passenger Yard. Illustrated description of tracks, platforms, etc. 2000 w. Eng Rec—June 18, 1910. No. 14995.

Track Construction.

Report for Austria, Hungary, Bulgaria, Rumania, Servia, and Turkey on the Question of Strengthening the Track with a View to Increasing the Weight of Locomotives and the Speed of Trains. Hermann Rosche. Ills. 21000 w. Bul Int Ry Cong—May, 1910. No. 15268 G.

Track Maintenance.

The Health of Trackmen (Quelques Chiffres à propos de l'Hygiene des Cantonniers). M. Becker. A report on the mortality and health of maintenance-of-way employees on French railways. 7500 w. Ann d Ponts et Chaussees—1910—II. No. 14803 E + F.

Tunnels.

Railway Tunnels: Cross Sections, Grades, Lining and Drainage. Abstract of the report of the Committee on Roadway, presented at meeting of the Am. Ry. Engng. & Main. of Way Assn. giving information as to the practice of different railways. Also editorial. 7500 w. Eng News—June 2, 1910. No. 14515.

Turntables.

A 120-Ft. Turntable for Handling Mallet Locomotives with Their Tenders; A., T. & S. F. Ry. Illustrated description of a special type of turntable designed by Frank H. Adams. 1500 w. Eng News—June 23, 1910. No. 15135.

TRAFFIC.

Freight Classifications.

Car Load Ratings and Mixed Car Loads. R. N. Collyer. From a paper before the N. Y. Traffic Club. Suggestions and discussion of differences in classification principles. 5000 w. Ry Age Gaz—June 3, 1910. No. 14541.

Side Tracks.

Side Track Agreements. Louis Jackson. Discusses private side tracks for shippers, explaining the agreements. 1000 w. Ry Age Gaz—May 6, 1910. No. 13808.

Tonnage Rating.

Tonnage Rating for Fast Freight Trains. J. G. Van Zandt. Discusses methods of adjustment. 3500 w. Ry Age Gaz—June 17, 1910. Serial. 1st part. No. 14978.

MISCELLANY.

Accidents.

Compensation and Compensation Acts. Frank V. Whiting. Read before the Assn. of Ry. Claim Agents. Reviews the laws of various countries, and discusses features that have not been given proper attention. 2500 w. Ry Age Gaz—June 24, 1910. No. 15155.

Apprenticeship.

The Apprenticeship System of the New York Central Lines. C. W. Cross. From an address delivered before the Int. Master Boiler Makers' Assn., describing the system. 2200 w. Boiler Maker—June, 1910. No. 15122.

Argentina.

The Argentine Centenary. The present number reviews the railway development of the Argentine Republic. 2500 w. Engng—May 13, 1910. Serial. 1st part. No 14197 A.

Australia.

The Victorian Railways. Editorial review of the latest report of these Government Railways, showing the satisfactory condition. 2200 w. Engng—June 3, 1910. No. 14752 A.

Brazil.

The Railways of Brazil. Lionel Wiener. First of a series of articles on the railway development. 6500 w. Cassier's Mag—May, 1910. Serial. 1st part. No. 13955 B.

Depreciation.

The Necessity of Depreciation Reserves. Henry L. Gray. Gives the writer's views and conclusions reached after a study of the subject. 2000 w. Ry Age Gaz—May 27, 1910. No. 14489.

Education.

See same title, under INDUSTRIAL ECONOMY.

European Railways.

Continental Railway Investigation. The present number gives a report of Austria-Hungary. 1000 w. Engr, Lond—April 29, 1910. Serial. 1st part. No. 13865 A.

Exhibitions.

Some English Exhibits at Buenos Ayres Exhibition. First of a series of articles giving illustrated descriptions of some of the exhibits. 1200 w. Engr, Lond—May 6, 1910. Serial. 1st part. No. 13980 A.

Government Ownership.

Impending Changes in the British Railway System. W. M. Acworth. The report of the Board of Trade Ry. Conference presented to both Houses of Parliament by command of his Majesty. Also editorial. 6000 w. Eng News—May 19, 1910. No. 14122.

Graphical Charts.

Graphical Study of Information. Prof. H. Wade Hibbard. An explanation of the plotting into diagrams of data of every sort. Ills. 4000 w. Pro W Ry Club—March 15, 1910. No. 14277 C.

Legislation.

Main Points of the New Railway Law. A statement concerning the law that takes effect Aug. 18th, 1910. 500 w. Ry Age Gaz—June 24, 1910. No. 15154.

Norway.

The New Christiania-Bergen Railway (Die neue Hochgebirgsbahn von Kristiania nach Bergen). Sigvard Heber. Describes a line through mountainous country. Ills. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—April 16, 1910. No. 14236 D.

Organization.

The Motive Power Department Organization of the Chicago, Burlington & Quincy. M. K. Barnum. Charts, showing graphically the relations, with explanations. 3000 w. Ry Age Gaz—May 6, 1910. No. 13811.

Panama.

The Panama Railroad and It's Relation to the Panama Canal. Ralph Budd. Reviews briefly the history of transportation facilities across the isthmus, describing the building and rebuilding of the railroad, the relocation of the line, unusual features of construction, etc. An Historical Sketch by Joseph E. Murphy is given. Also general discussion. Ills. 11500 w. Jour W Soc of Engrs—April, 1910. No. 14327 D.

Purchasing.

See same title, under INDUSTRIAL ECONOMY.

South America.

Railway Development in South America. Information concerning the railroad lines of the different countries. 3500 w. Ry & Engng Rev—May 7, 1910. No. 13805.

Statistics.

The Necessity of Care in the Interpretation of Railway Statistics Used Comparatively. Ernest Ritson Dewsnup. A survey of important statistics showing their limitations. 7500 w. Ry Age Gaz—May 13, 1910. No. 13900.

Statistics of Railways for Year Ended June 30, 1908. Editorial review of the twenty-first annual report. 1200 w. Ry Age Gaz—June 3, 1910. No. 14540.

STREET AND ELECTRIC RAILWAYS.

Brake Shoes.

Brake-Shoe Standardization. J. A. Panton. Read before the Tram. & Lgt. Rys. Assn. Considers types and present-day requirements, explaining the saving that could be effected by standardization. Ills. 5000 w. Tram & Ry Wld—June 2, 1910. No. 15112 B.

Car Maintenance.

Rolling Stock Maintenance Organization of the Massachusetts Electric Companies. Gives diagram showing the general organization, forms used, reports, etc., with explanatory notes. 2000 w. Elec Ry Jour—June 4, 1910. No. 14537.

Economics.

City Transportation. Frank Foster. Problems due to municipal congestion are discussed. 2500 w. Cassier's Mag—June, 1910. No. 14643 B.

Tramway Economics. J. R. Salter. Read before the Tram. & Lgt. Rys. Assn. Deals with the relation between receipts, car-mileage and working expenses, and the general commercial principles involved. 6000 w. Tram & Ry Wld—June 2, 1910. No. 15113 B.

Elevated Railways.

Reconstruction of Part of the Manhattan Elevated Railway. Illustrated description of the work of depressing an elevated railway on each side of Manhattan Bridge, New York, to increase the clearance at its intersection with the Second Ave. line. 1500 w. Eng Rec—May 28, 1910. No. 14417.

Replacing and Depressing the Manhattan Elevated Railway. Illustrates and describes work in New York City to provide clearance for the elevated railway trains under one of the approach spans of Manhattan Bridge. 3500 w. Eng Rec—June 11, 1910. No. 14688.

Carrying an Elevated Railway Across a Skating Rink by a 100-ft. Truss Span. Plans and description of work in Chicago, by which the Metropolitan Elevated Ry. is carried across a skating rink at Paulina

Street. 800 w. Eng News—June 16, 1910. No. 14913.

A Long Reinforced-Concrete Railway Viaduct Through the City of Rotterdam, Holland. Illustrated description of a viaduct about 5300 ft. long, carrying a two-track heavy electric-railway line. 1200 w. Eng News—June 16, 1910. No. 14907.

See also Operation, under STREET AND ELECTRIC RAILWAYS.

Interurban.

Traffic and Physical Development of an Iowa Railroad. Illustrated account of the system of the Ft. Dodge, Des Moines & Southern Railroad Co. which operates a combination steam and electric railroad. 2000 w. Elec Ry Jour—June 25, 1910. No. 15152.

Italy.

Electric Traction on the Giovi Railway (La Trazione elettrica ai Giovi). The first part describes the central station for this line out of Genoa. Ills. Serial. 1st part. 3000 w. Ing Ferro—May 16, 1910. No. 14852 D.

Locomotives.

Electro-Mechanical Locomotives. A. P. Chalkley. Illustrated discussion of the possibilities of combination electric propulsion. 2000 w. Cassier's Mag—June, 1910. No. 14638 B.

Running a N. Y., N. H., & H. Electric. W. B. Kouwenhoven. Brief description of the equipment and operation of one of these electric locomotives. Ills. 2500 w. Ry & Loc Engng—June, 1910. No. 14584 C.

The Electric Locomotives of the Wengern Alpine Railway (Die elektrischen Lokomotiven der Wengernalpbahn). H. Morgenthaler. Description of locomotives for a Swiss rack railway. Ills. 4000 w. Schweiz Bau—May 28, 1910. No. 14885 B.

Electric Locomotives on the Dessau-Bitterfeld Line (Die Lokomotiven der elektrischen Zugförderungsanlage Dessau-Bitterfeld). W. Heyden. Describes passenger and freight locomotives. Ills. 2500 w. Elek Kraft u Bahnen—May 24, 1910. No. 15062 D.

Maintenance.

Care and Handling of Electrical Equipment, New York Central & Hudson River. F. E. Lister. Describes interesting features of care found necessary in the maintenance of the equipment for the 58 miles of its electric division into New York City. 4000 w. Ry Age Gaz—June 3, 1910. No. 14547.

Management.

The Transportation Department of the Metropolitan Street Railway, New York. An illustrated account of improvements introduced in the transportation methods. 3000 w. Elec Ry Jour—June 25, 1910. No. 15151.

Mono-Rail.

The Mechanical Principles of Brennan's Mono-Rail Car. Henry T. Eddy. Aims to develop the mathematics and physics of the gyroscope, and their application to this car. Ills. 5000 w. Jour Fr Inst—June, 1910. No. 14922 D.

Mono-Railways (Einschienenbahnen). E. A. Ziffer. A review of the various systems proposed. Ills. 5200 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens —April, 1910. No. 14853 F.

Operation.

Passenger Traffic Handling on Elevated Trains at the Manhattan Terminal of the Brooklyn Bridge. Explains the highly efficient train and passenger handling system that has been developed to meet the unusual requirements. 2000 w. Eng News —May 26, 1910. No. 14401.

Railless.

Railless Traction. Harry England. Discusses the use for suburban car service. 4000 w. Tram & Ry Wld—June 2, 1910. No. 15114 B.

The Trackless Trolley System in Italy. Illustrates and describes details of the Filovia system in Italy. 700 w. Tram & Ry Wld—June 2, 1910. No. 15111 B.

Mercedes-Stoll Trackless Trolley System. Illustrates and describes applications of this system, giving details of lines at work. 800 w. Tram & Ry Wld—June 2, 1910. No. 15110 B.

Subway Cars.

Center Side Door Steel Cars for New York Subway. Illustrated detailed description. 3000 w. Elec Ry Jour—June 18, 1910. No. 14968.

Subway Signalling.

Speed Control Signals on the Interborough. Extracts from a talk by J. M. Waldron on the arrangements introduced on the express tracks of the subway in Manhattan by which trains can safely be run closer together. 1200 w. Ry Age Gaz—June 17, 1910. No. 14979.

Track Maintenance.

Some Suggestions for Economical Track Maintenance and Construction. Martin Schreiber. Illustrated discussion of practical ideas in connection with track work. 2200 w. Elec Ry Jour—June 18, 1910. No. 14967.

Trolley Lines.

Brooklyn Line Department—The Novel Iron-Bar Overhead Construction. Illustrated description of this bar construction, which is used wherever traffic is heavy and at important intersections. 800 w. Elec Ry Jour—June 11, 1910. Serial. 1st part. No. 14673.

Wire Suspension.

Electric Railway Catenary Trolley Construction. W. N. Smith. Reviews current practice, calling attention to features that seem to be open for discussion. Ills. 9000 w. Pro Am Inst of Elec Engrs—June, 1910. No. 14954 F.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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THE ROUTING DIAGRAM AS A BASIS FOR LAYING OUT INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's article is an important part of the systematic and comprehensive study of the "Planning and Building of Industrial Plants" which was begun in THE ENGINEERING MAGAZINE a year ago, and was continued by the analysis of "Machine-Tool Equipment for Metal-Working Plants" presented in our June and July issues. The entire series, enlarged, adapted and revised, will soon be published in book form.—THE EDITORS.

THE primary purpose of this article is to call attention to the advantages that can be derived from the use of the graphical routing diagram as a basis for the planning of industrial plants. This diagram, as its name implies, indicates the paths or routes followed by the materials of manufacture when passing from their crude to their finished state, and in its final development it absolutely defines the plant in all particulars of layout.

Many industrial plants are seriously handicapped through the fact that the *arrangement* of their departments and equipment imposes operating expenses that are almost prohibitive. If errors are made in the selection of certain machines or other detail features, they can usually be corrected at comparatively small expense. On the other hand, if the arrangement of departments and equipment, and therefore the character of the buildings, has been incorrectly solved, the resulting plant may be such as practically to prohibit the establishment of correct conditions unless a very great monetary loss is incurred. It is becoming generally appreciated that this is a question deserving the utmost consideration, and as the efficiency of a given plant is governed primarily by the *manner* in which its layout is worked out, a method that has been found to be sound would appear to merit considerable attention.

The first step when preparing to lay out an industrial plant is, of course, to become thoroughly conversant with all the manufacturing requirements imposed by the particular business to be housed. This phase of the subject was discussed at considerable length in a series of papers entitled "The Planning and Building of Industrial Plants," published in THE ENGINEERING MAGAZINE September to December, 1909. When working up the layout, it is of primary importance that all these detail factors should be considered collectively so that their inter-relationships can be properly discerned. The graphical method allows of this more readily than any other.

Figure 1 is presented as an illustration of the routing diagram in its most elemental form. It pertains to a series of conditions not particularly unlike those very frequently presented. In the upper left-hand corner is shown in plan a factory used exclusively for the manufacture of pianos. All the buildings, except the one marked with the letter "F," were in existence at the time the work was undertaken. The object in view was the establishment of conditions more favorable to economical manufacture of pianos than were afforded by the existing layout, which was the result of a growth extending over many years but not in accordance with any definite plan for the ultimate development. In addition, a very material increase in output was to be provided for. The product consisted of pianos of both grand and upright types, but for the purpose of simplicity the lines on the diagram have been drawn in for grand pianos only.

A grand piano is composed of a number of principal units, only seven of which we need consider. The essential parts of five of these, viz.; the top, rast, rast bracing, rim, and keyboard, are made of lumber and so start in their crude shape at the lumber pile. The plates are made of metal, and in this case the preliminary operations were performed in a shop not a part of the group of buildings in question. The sounding boards were also made at another shop. The location of the main lumber storage was originally as shown on the plan, but the disposition of the space in buildings D, C, B and E was quite different from that indicated. The first diagram prepared showed as accurately as was possible the manner in which the materials progressed through the plant at the time of the initial investigations, and a study of this diagram formed the basis for a series of revised layouts. These showed the paths of travel in two directions only, from floor to floor and in a direction parallel to the front property line, as it was necessary to establish broad relationships before taking up the routing in detail. The floor space required for the estimated increase in output was approximated and, as buildings D, C, B and E were satisfactory for general manufacturing purposes, it was found to be practicable to dispose of their floors in a manner best adapted to the routing of the product. The studies showed the desirability of extending the plant at the point indicated on the plan by building F. Finally, diagrams showing the various floors in plan were prepared, but insofar as is allowed by a diagram showing routing in elevation only, the final arrangement is shown by Figure 1. The sequence of the principal operations is indicated as well as the points where the various units are assembled.

While a diagram which is carried out in no greater detail than Figure 1 gives comparatively little information that is of specific value as a basis for the design of buildings and installation of equipment, yet it is a *key* to the manufacturing problems as a whole and a useful and, in fact, a necessary step toward the final solution.

When decisions have been reached as to the areas of departments, their general arrangement, and whether or not they must be located on the ground floor, and when the necessary trucking and railroad facilities have been defined and a site tentatively chosen, a more advanced form of routing diagram can be prepared than was illustrated by Figure 1. If the building is of the single-story type, the routing can be satisfactorily shown in a manner indicated by Figure 6, but if the buildings are multiple-story this method requires the preparation of wholly separate diagrams for each floor and the advantages of graphical representations are not nearly so pronounced.

Figure 3* exemplifies the proper manner of recording graphically the routing of the product in multiple-story buildings. Of course, in actual practice the same result can be approximated through showing the floors in outline perspective as in Figure 4, leaving out the building detail. Diagrams of this character should be made prior to locating individual machines and, in fact, they become the guide for the performance of this work. The departments need to be considered individually only when locating machine equipment, and the routing diagrams showing the progress of materials from machine to machine represent the last step to which the work can be carried.

We will now consider the principal factors which brought about the diagram illustrated by Figure 3. In this case the plant indicated by the perspective comprises entirely new buildings to accommodate a business formerly conducted in another factory. The broad requirements for which the plant was laid out were a daily output of 150 dozen rough stiff hats, 300 dozen finished stiff hats, 100 dozen rough soft hats, and 150 dozen finished soft hats, making 700 dozen or 8,400 hats per day. It should be explained that rough hats are made by certain manufacturers for customers who desire to perform the finishing operations themselves. These finishing operations comprise, for stiff hats, operations 29 to 42 and for soft hats, 21 to 31 inclusive (see Figure 3). It will not be necessary to consider all of the operations individually. The preparation of the chart required only such knowledge concerning the detail methods employed as was necessary to give a thorough understanding of the manner in which hats are made. The problem primarily was to plan a factory that would immediately provide for the output of hats specified above and also provide for reasonable growth of departments.

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* Fig. 3 is a folding insert facing page 816.

The preliminary routing studies revealed the fact that the work of the manufacturer comprises three clearly defined series of operations: first, those dealing with the skins from which the fur is obtained for making the hats, including the removal and preparation of the fur; second, the forming and shaping of the hat body up to a point where the "rough" hat is produced; and third, the finishing operations that must be performed upon the rough hat body in order to bring about the final product.

The first series of operations comprises operations 1 to 4 inclusive for both soft and stiff hats. Operations 2, 3, and 4 represent in each case a series of distinct processes performed in part by labor but principally by special machinery. After the fur and hair have been cut from the skin, it is imperative that it should not come in contact with water. Further, the blowing which is done for the purpose of removing the hair from the fur is performed in machines made up of a series of compartments into which air is blown and, owing to the speed at which the fans operate, a reasonably substantial foundation is required. As the blowing equipment occupies a very considerable part of the total space required for the performance of the operations in question, the nature of the enclosure used to house them should be suited primarily to the requirements imposed by it. In this case it was decided to arrange the blowers in series of twelve sections, running parallel and across the building.

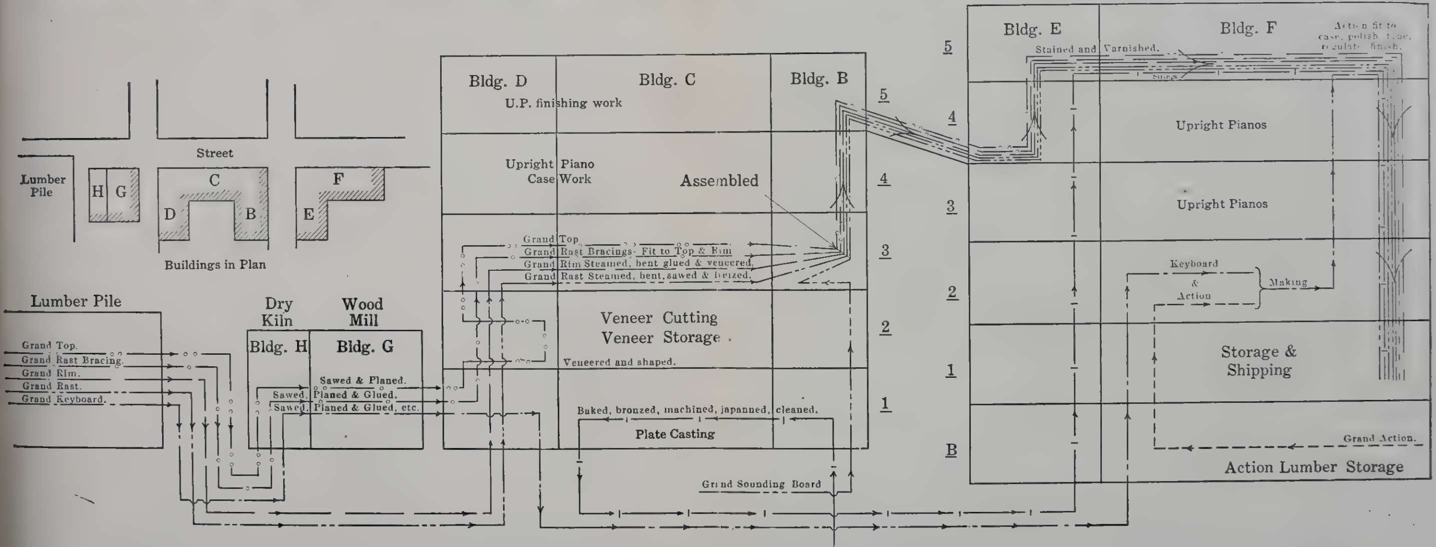
The second series of operations comprises numbers 5 to 28 inclusive, which are characterized by the fact that the principal processes in this group are effected through the alternate wetting and drying of the product from which the hats are made. Operation 6 forms the loose dry fur into the felt body which is the first definite form assumed by the product when making stiff or soft hats (Figure 2). This is accomplished by feeding the fur, which has been previously weighed, into the top of a cylindrical shell about 4 feet in diameter and 5 feet high, at the bottom of which is a rotating table that carries a finely perforated copper cone about 24 inches in

Buildings F and E Showing Bridge to Building B

Action Department Second Floor Building F

Finishing Department Fifth Floor Building F

Building F which was the Addition to the Plant



ELEMENTARY FORM OF ROUTING DIAGRAM (IN ELEVATION) SHOWING SEQUENCE IN PRINCIPAL OPERATIONS ON GRAND PIANOS. THIS IS AN ELEMENTARY APPLICATION OF THE GRAPHIC REPRESENTATION OF ROUTING TO AN INDUSTRIAL PROBLEM.

height. The fur entering the cylinder in a finely divided state is deposited against this copper cone by means of the suction created by an exhaust fan, which draws the air through the perforations and down through an opening in the spindle of the rotating table. The rotary motion is only for the purpose of assuring the deposit of a uniform layer of fur upon the cone. When the requisite amount of fur has been so deposited, the cylindrical shell is opened, wet cloths are wrapped around the cylinder to hold the fur in place, and it is then lowered into a tank of hot water. This dipping starts up the felting action which is the basic principle upon which the manufacture of hats of this kind depends. Each individual fibre of the fur shows, under microscopic examination, numerous small barbs. The individual fibres are worked together by the interlocking of these barbs during the immersions in hot water and the subsequent hardening and sizing processes, which merely consist in *working* or *kneading* the hat bodies upon a bench or in machines.

This group of operations contains the stiffening processes, numbers 15, 16, 17, and 18, which in reality form a distinct sub-group by themselves. The presence of large quantities of alcohol introduces a considerable fire hazard and, in addition, the equipment required for this work necessitates special building features. Except for these stiffening operations, it will be seen that the processes of the second group merely subject the felt body to a series of gradual changes in shape in a manner that necessitates repeated water immersions. Therefore, the work is characterized by the fact that large amounts of very hot water are used, requiring special provision for drainage and ventilation and calling for complete segregation from the first and third series of operations, in connection with which the complete absence of water is a necessity. Another feature pertaining to this part of the work is that all the product passing through the processes just referred to is upon stock orders rather than upon customers' orders and, while this condition might not prevail in another hat factory, it was an established practice in this instance.

Operations 29 to 44 for the stiff hats and 21 to 33 for the soft hats are all performed through the medium of dry heat—at least, those that have to do with changing the form of the crown or brim. Further, whereas the hats are made for stock orders during the second series of operations and can be stacked in piles one over the other, so requiring very little room for storage between operations, during the third series they are made for customers' orders and must be handled in much smaller lots; and as the crowns have been formed they must be stored individually in special racks provided for the purpose. Consequently, when in transit they occupy a large amount of floor space as compared with that needed prior to the formation of the rough hat body.

Several diagrams were prepared before the final one illustrated by Figure 3 was produced. It will be seen that a separate building is provided for the first series of operations, including also the first operation of the second series, viz., the forming and hardening of the hat body. Operation 6 is housed in the same building as operations 1 to 5, because the fur should be carried the least distance possible between blowing and forming, and also because a structure suitable for the installation of blowing machines is adapted also for the comparatively heavy forming equipment. Further, these two types of equipment require the major portion of the power needed for the entire plant; so, as the direct drive had been decided upon, it was considered advisable to locate them in as close proximity as possible and near the engine room. There are no industrial objections to the use of a multiple-story building for these operations; in fact, a study of the diagram will show that such a structure has certain advantages; consequently a three-story building was adopted.

The requirements of the operations comprising the second group, exclusive of the stiffening processes, were such as to make a single-story building with adequate roof ventilation and floor drainage preferable. The locations of the various departments were worked out with a view to minimizing the travel of the hat bodies and at the same time making possible the use of but one dry room serving both stiff and soft hats. It will be seen that the dry room is located in the center of the building, and although all the soft hats and stiff hats must go into this department four times before they pass to the third and last series of operations, this is accomplished with a minimum of handling. There are six means of entrance or exit to the dry room, allowing practically a continuous movement of material in well defined directions and obviating the possibility of congestion.

The stiffening operations are housed in a separate fireproof enclosure designed especially for this purpose and separated from the rest of the plant in order to confine the area subjected to extraordinary fire risk.

It has been pointed out before that a very considerable amount of space is occupied in connection with the third series of operations for hats in transit, and on this account the total floor area is much greater than is required for the preceding group. Further, there is a great deal of the work that is performed upon benches which requires very good light. Therefore, it was decided to adopt a three-

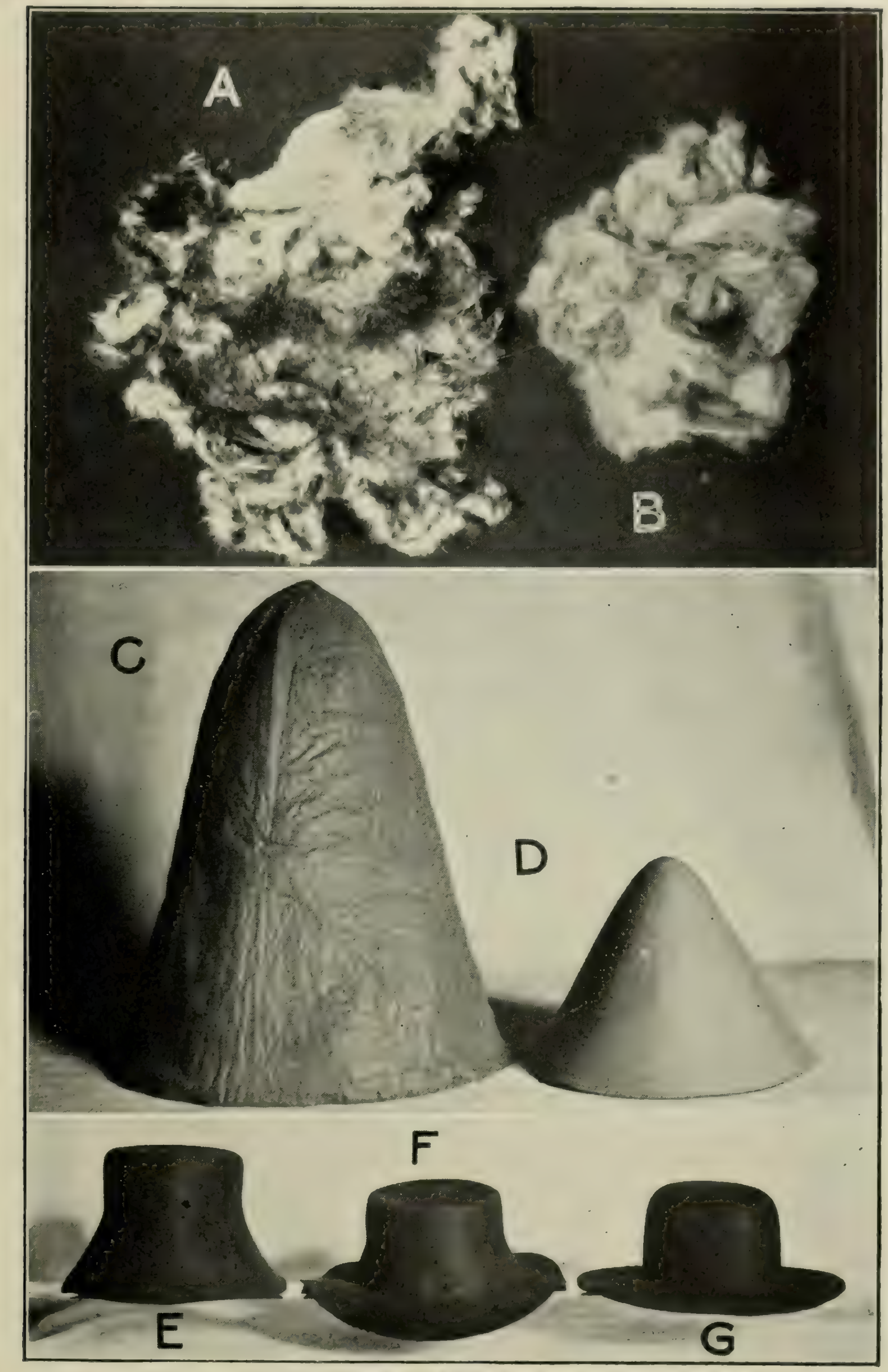
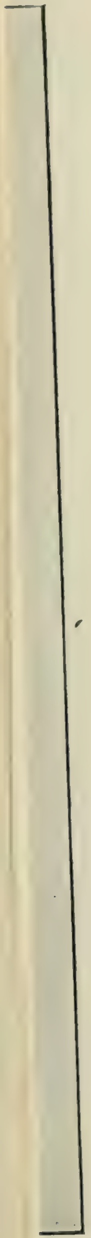


FIG. 2. STAGES IN THE MANUFACTURE OF STIFF HATS.

A, rabbit fur after operation No. 3; B, rabbit fur after blowing, operation No. 4; C, hat body after operation No. 6; D, hat body after operation No. 14; E, hat body after operation No. 23; F, hat body after operation No. 24; G, hat body after operation No. 28.

story building, in order to combine the necessary floor space and bench room along windows and at the same time a desirable routing of the materials. It will be seen that considerably more space is required for finishing the stiff hats than for the soft hats. In order to keep the two kinds of work segregated, the first and second floors are utilized for the former and the third floor for the latter. These finishing operations which are performed in the building to the extreme right of the diagram constitute a complete business in themselves. The rough hats are stored in the first floor directly in the foreground of the perspective, and are shipped from the finished-stores department located at the far end of the same floor and directly adjoining the railroad siding.

While it was not practicable to include in diagram No. 3 a very great amount of detail, yet it should be pointed out that it is through the medium of such a diagram that the over-all dimensions were fixed and building characteristics determined. It will be clear, after it has been studied in detail, that every square foot of floor space is provided for a specific purpose, so that the expenditures for the plant were confined strictly to those needed for the output immediately desired. In order to comply with this requirement, the building provided for the second series of operations was designed to the dimensions indicated rather than a single rectangle in outline. It will also be noted that the second and third floors of the finishing building have been set back so as to provide just the areas needed. However, the plant can be extended readily to provide for growth, without necessitating a rearrangement of departments, except for the equipment used in connection with operations 10, 11, and 12. This would have to be moved into an extension of the building in order to allow for the growth of the dry room. In general the buildings for the first and third series of operations would be extended into the foreground of the illustration, and the building for the second series of operations would be extended at either or both ends, depending upon whether the increase was in stiff or soft hats or both. The only limiting factors in the extension of the plant as a whole are those imposed by the location of the stiffening building and the size of the property. The hat industry is a particularly good one to refer to as a means of illustrating the advantages of the graphical routing diagram, as the process work consists in a large measure of the performance of work upon but a single article, causing its gradual change from the first felt cone to the finished hat. In the majority of industries work must be performed upon a great number of small parts which, of course, makes the routing problem a very much



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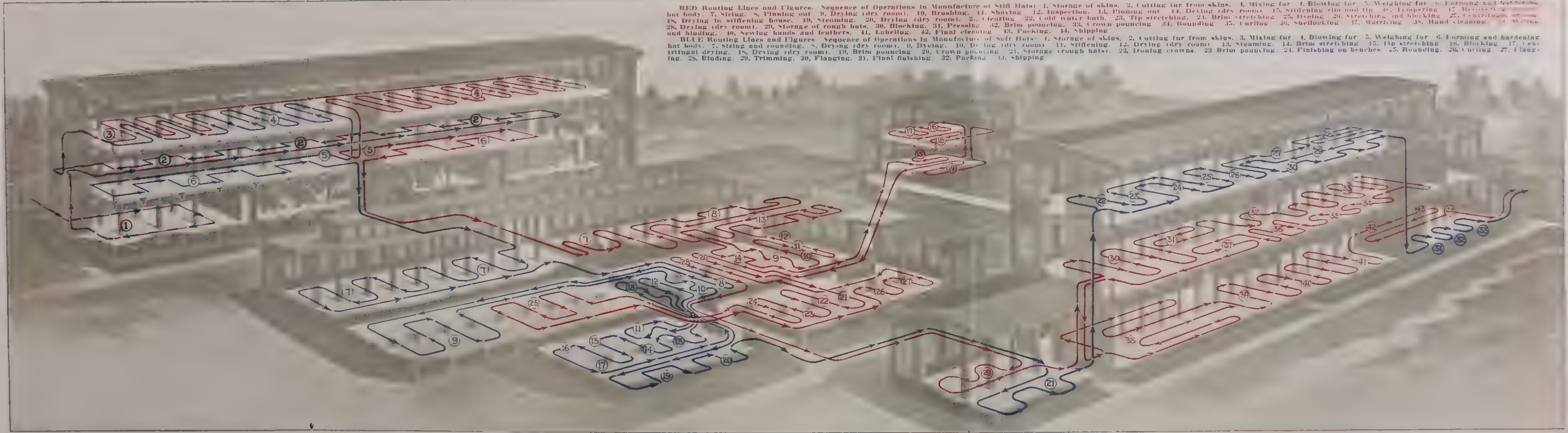


RED Routing Lines and Figures. Sequence of Operations in Manufacture of Stiff Hats: 1, Storage of skins. 2, Cutting fur from skins. 3, Mixing fur 4, Blowing fur 5, Weighing fur 6, Forming and hardening hat body. 7, Sizing. 8, Pinning out 9, Drying (dry room). 10, Brushing. 11, Shaving 12, Inspection. 13, Pinning out 14, Drying (dry room) 15, Stiffening rim and tip 16, Tempering 17, [illegible] 18, Drying in stiffening house. 19, Steaming. 20, Drying (dry room). 21, Clearing 22, Cold water bath. 23, Tip stretching. 24, Brim stretching 25, Dyeing 26, Stretching and blocking 27, Centrifugal [illegible] 28, Drying (dry room). 29, Storage of rough hats. 30, Blocking. 31, Pressing 32, Brim pouncing. 33, Crown pouncing 34, Rounding 35, Curling 36, Shellacking 37, Matricing 38, Hand cleaning 39, [illegible] and binding. 40, Sewing bands and leathers. 41, Labeling. 42, Final cleaning 43, Packing. 44, Shipping

BLUE Routing Lines and Figures Sequence of Operations in Manufacture of Soft Hats: 1, Storage of skins. 2, Cutting fur from skins. 3, Mixing fur 4, Blowing fur 5, Weighing fur 6, Forming and hardening hat body. 7, Sizing and rounding. 8, Drying (dry room). 9, Dyeing. 10, Drying (dry room) 11, Stiffening. 12, Drying (dry room) 13, Steaming. 14, Brim stretching 15, Tip stretching 16, Blocking 17, Centrifugal drying. 18, Drying (dry room). 19, Brim pouncing 20, Crown pouncing 21, Storage (rough hats). 22, Ironing crowns. 23 Brim pouncing 24, Finishing on benches 25, Rounding. 26, Curling 27, Flanging. 28, Binding. 29, Trimming. 30, Flanging. 31. Final finishing 32, Packing 33, Shipping

DIAGRAMMATIC LAYOUT OF PLANT FOR THE MANUFACTURE OF MEN'S [illegible] ARRANGEMENT CONSISTENT WITH THE MOST ECONOMICAL ROUTING OF THE PRODUCT AND PERMITTING [illegible]

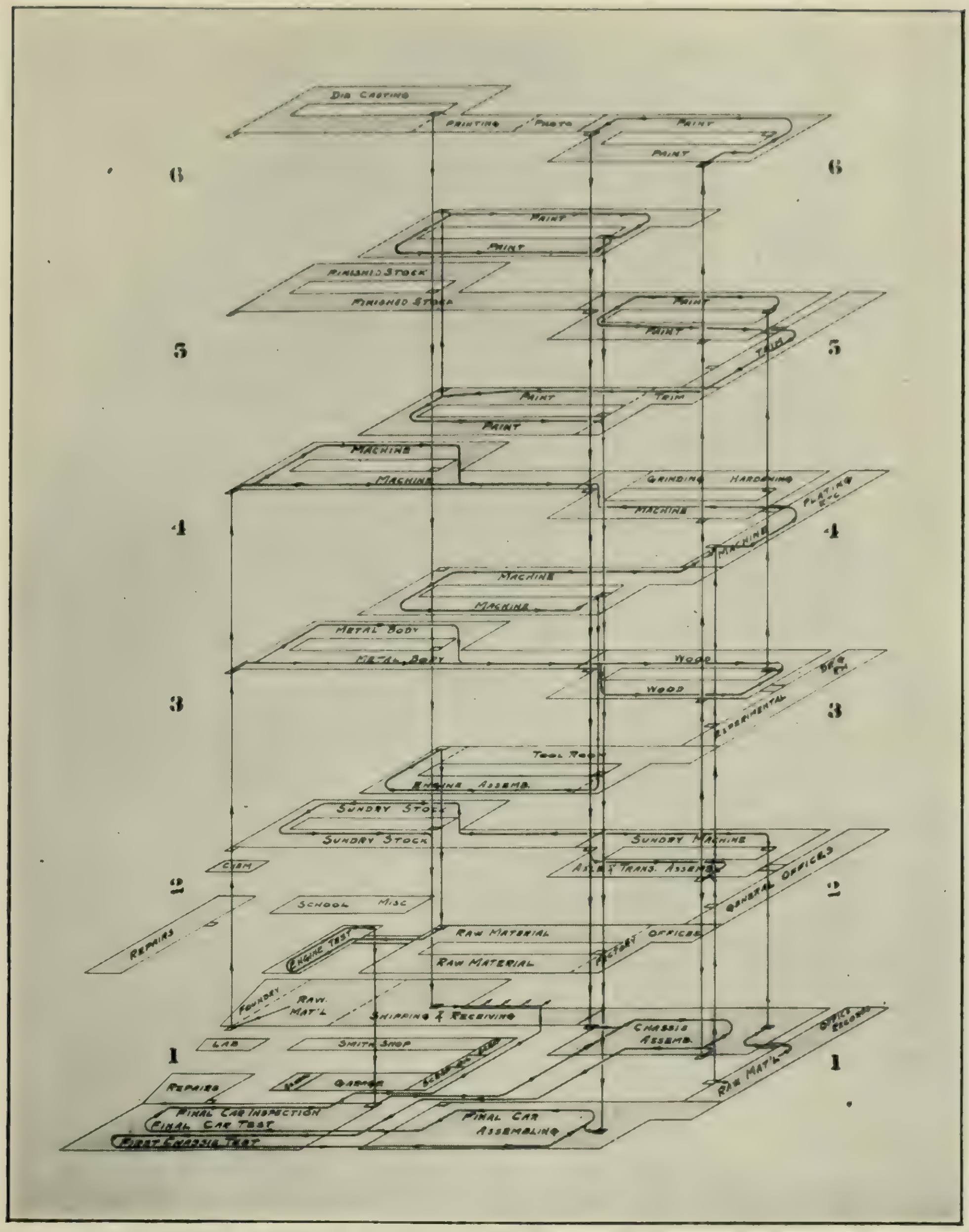


FIG. 4. PERSPECTIVE ROUTING DIAGRAM, IN OUTLINE, SHOWING PATHS FOLLOWED DURING MANUFACTURE OF PRINCIPAL UNITS ENTERING INTO GASOLINE AUTOMOBILES. SEE PAGE 818.

more complex one. Under such circumstances there is almost sure to be a considerable amount of travel in a backward direction, and the arrangement of departments and equipment that is finally adopted will represent, at the best, but a compromise of many conflicting conditions. In contrast with this state of affairs, it will be noted that the routing lines shown in Figure 3 progress uniformly from the point where the work commences to the shipping department, and indicate to all intents and purposes the actual paths over which the specially designed trucks used for transporting the hats are moved.

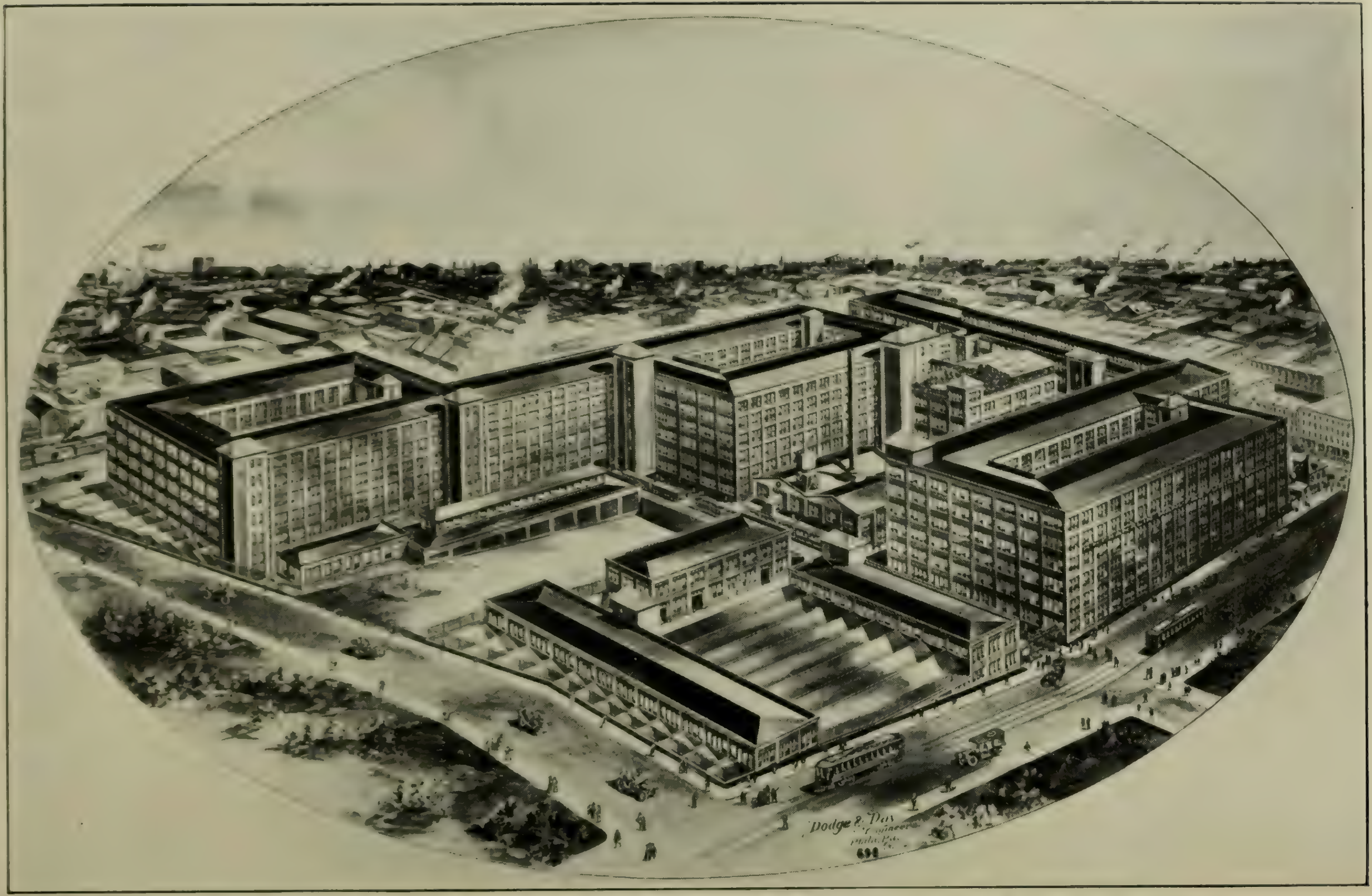


FIG. 5. EXTERIOR VIEW OF AUTOMOBILE PLANT TO WHICH THE ROUTING DIAGRAM (FIG. 4) RELATES.

In actual practice it is not feasible to work up a number of alternate diagrams in as great detail as the one that has just been described, but a very satisfactory result can be secured by laying out the various floors of multiple-story buildings in outline perspective, indicating the routing lines in the manner shown in Figure 4. This diagram, like the one illustrating the progress of the materials through the hat factory, shows the plant as a whole but does not give in detail the actual routing that would take place within individual departments. Nor has any attempt been made to route the individual parts, numbering several thousand, that enter into the construction of a complete gasoline automobile. The diagram is in reality but a "key" indicating the principal paths of travel of materials from the point where they are received until they reach the shipping department in their completely assembled state. The detail routing for such a plant must be shown on large-scale drawings of individual departments. Figure 5 is a perspective view showing the exterior of the plant as a whole.

A diagram illustrating the fullest application of the routing principle is illustrated by Figure 6, which shows the layout of a plant used for the manufacture of wagon and carriage axles. In this instance the location of each piece of equipment is clearly indicated on the blue print and the routing lines show the exact paths followed by materials from the point where they are received until finished and ready for assembling with wheel boxes. This illustration was chosen as it represents a plant complete in every particular.

A consideration of the series of diagrams which accompany this article will serve, I am sure, to emphasize the fundamental importance of the routing problem as bearing upon the laying out of industrial plants. In order to develop the routing scheme properly one must make a thorough study of all the more important factors entering into the business that is to be housed, and on this account the routing diagram forms the logical basis upon which to develop and reconcile all detail considerations, for it is in this particular that they all have a common ground. The problem is in its essence one of determining the inter-relationships which should exist among an aggregation of acts and operations in order to accomplish a given result with maximum economy. Now, in order to determine whether a given series of acts or operations is a desirable one, it is imperative to consider the effects produced by each upon those that follow, for the conditions existing at every stage are the result of all prior acts or operations. Therefore, the primary problem that confronts the engineer engaged upon this work is to forecast accurately results

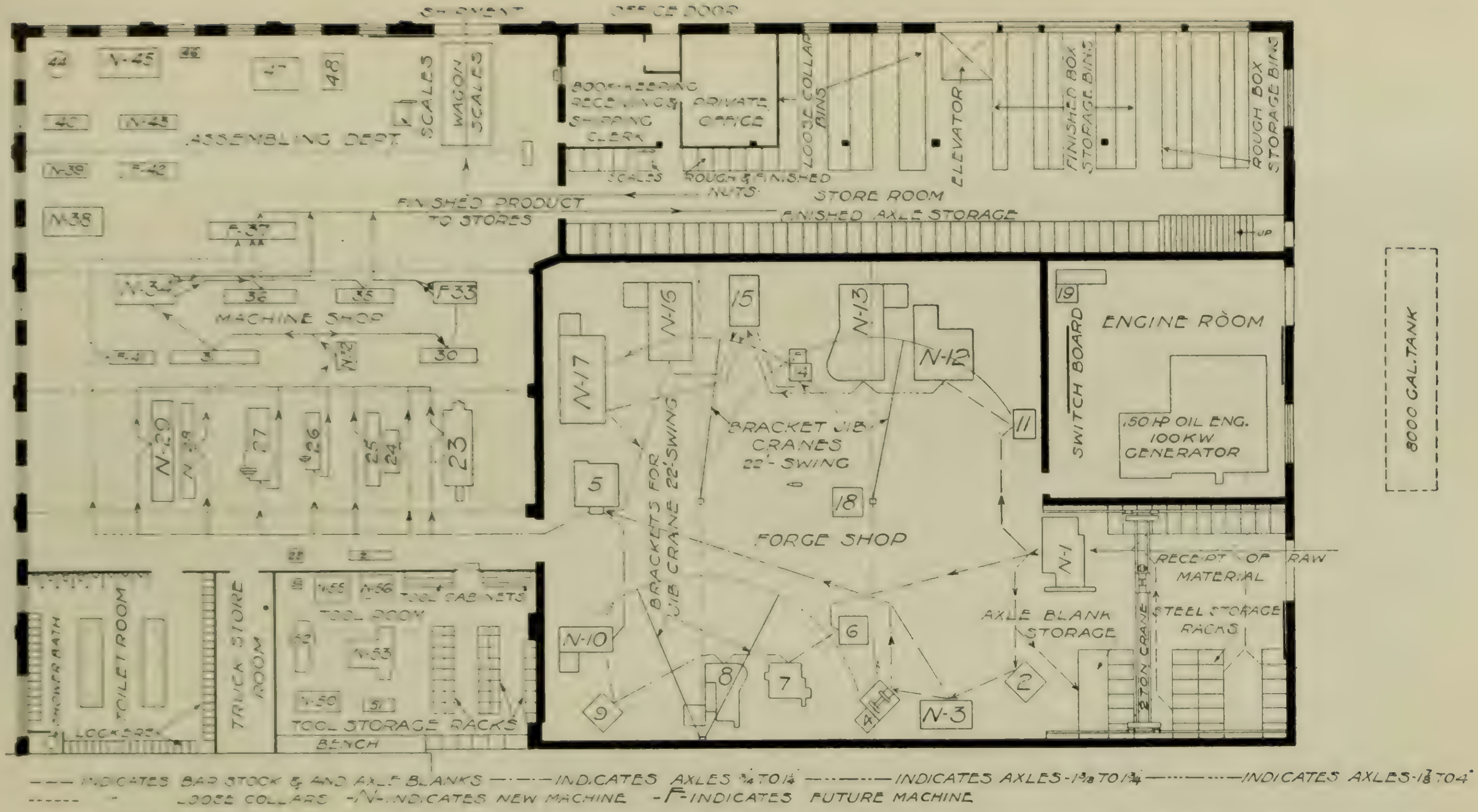
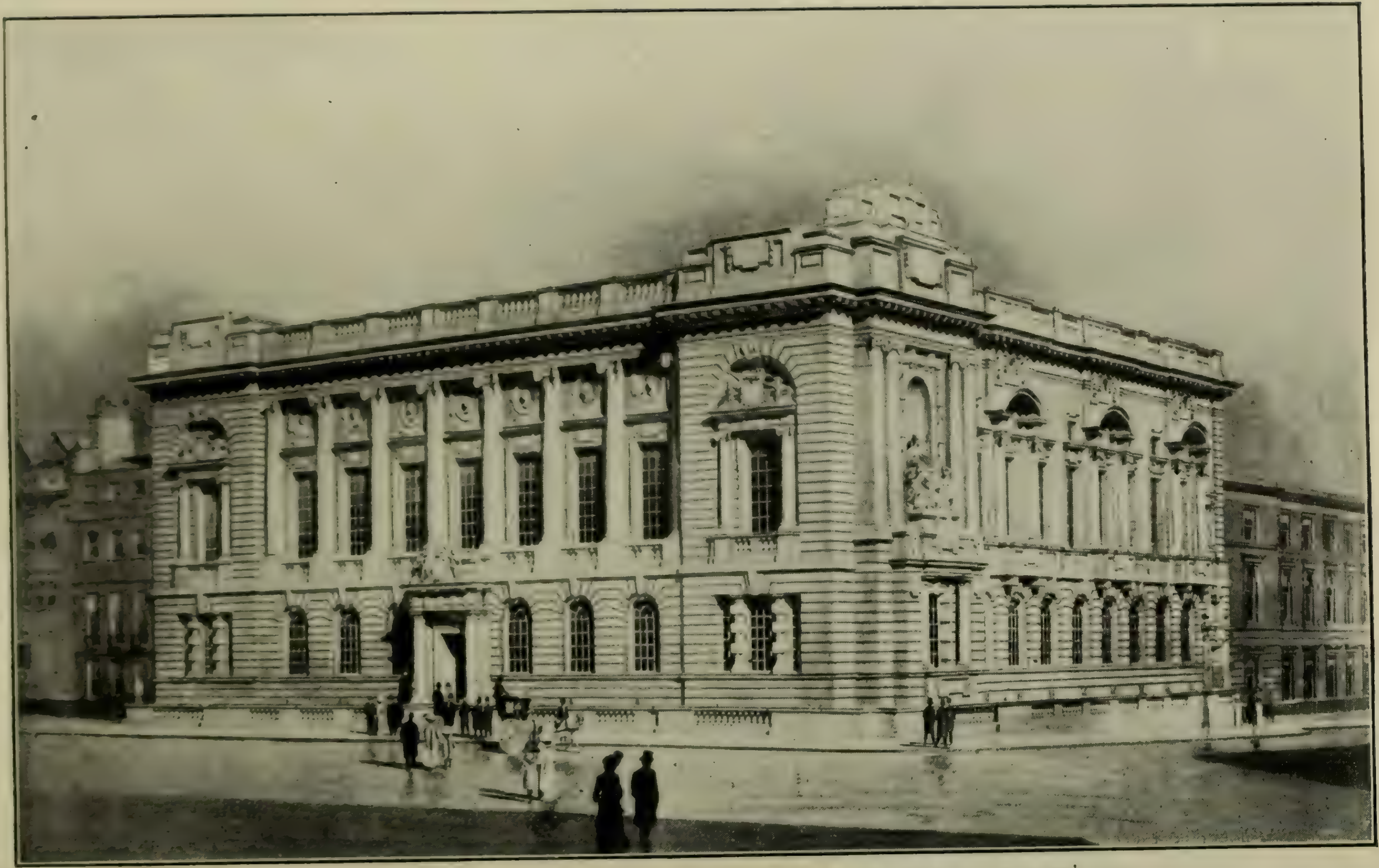


FIG. 6. DETAIL ROUTING DIAGRAM; MACHINE-TOOL EQUIPMENT AND PATHS OF PARTS IN A WAGON- AND CARRIAGE-AXLE PLANT.

1, 4-in. bar shear. 2, oil furnace. 3, forging press. 4, 100-lb. hammer. 5, clipping shear (old 3-in. bar shear). 6, oil furnace. 7, 2½-in. Ajax taper rolls. 8, 2½-in. upsetting machine. 9, oil furnace. 10, 400-lb. Yeakley pneumatic hammer. 11, oil furnace. 12, 4-in. taper rolls. 13, 4-in. upsetting machine. 14, punch press. 15, 24-in. by 72-in. oil furnace. 16, 600-lb. Yeakley pneumatic hammer. 17, No. 6 Williams White bulldozer. 18, oil furnace. 19, Queen City pressure blower and oil pump. 21, portable hydraulic axle-straightener (50 ton). 22, 18-in. by 18-in. oil furnace. 23, 1¼-in. triple axle ram. 24, 16-in. by 6-ft. Porter lathe. 25, 20-in. by 10-ft. Garvin lathe. 26, 1¾-in. single axle ram. 27, 3-in. single axle ram. 28, double-head axle lathe (Bridgeford). 29, 42-in. by 14-ft. engine lathe (30-in. lathe raised). 30, 20-in. by 8-ft. engine lathe (for filing work). 31, 22-in. by 12-ft. engine lathe (for filing work). 32, Whitney milling machine (for cutting oil grooves). 33, 1½-in. single-head Acme bolt-cutter. 34, 2½-in. ditto. 35, 20-in. by 8-ft. Johnson lathe. 36, 32-in. by 14-ft. Bishop lathe. 37, hydraulic press for forcing on loose collars. 38, double-head Acme 2-in. nut tapper. 39, nut-facing machine. 40, Monitor turret lathe for recessing nuts. 41, chucking lathe for loose collars. 42, 20-in. engine lathe (for finishing boxes). 43, ditto. 44, 1¼-in. quadruple box reamer. 45, 4-spindle drill (for reaming boxes over 1¼ in.). 46, 2-wheel grinder. 47, 36-in. by 18-in. case-hardening furnace. 48, tempering trough. 50, 14-in. by 6-ft. tool-room lathe. 51, 22-in. Sargeant drill press. 52, 20-in. by 20-in. by 5-ft. New Haven planer. 53, No. 2 universal milling machine. 54, 12-in. by 12-in. tool-tempering oil furnace. 55, Sellers No. 2 universal tool grinder. 56, surface grinder.

that will follow if certain procedures are carried out, and this can be done only be considering in regular sequence causes and effects, commencing with the initial factor. Consequently, the work must of necessity be handled in an orderly and consecutive manner, and if the habit of mentally grouping facts graphically is cultivated to the point where such images can be promptly summoned into existence, resulting conditions are much more readily anticipated.

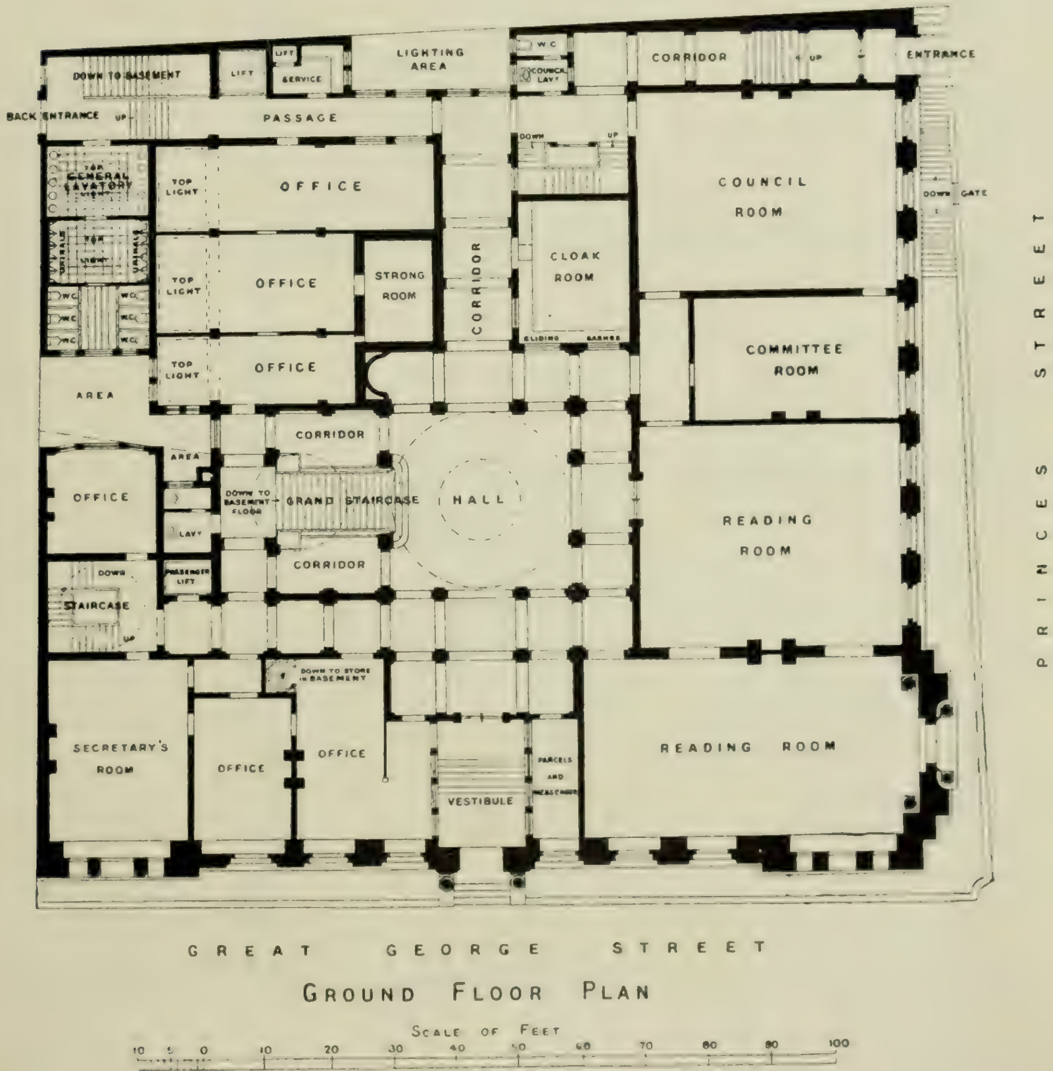
One of the principal factors entering into modern methods of industrial administration is that of scheduling the work from a central planning office in a manner that provides for the completion of each unit of work in a certain time. It is found that if such a system is properly established great economies result as compared with any results that are possible if no regular schedule is enforced. The importance of the schedule is best illustrated in connection with the operation of large railroad systems. They depend for their very existence upon the exact adherence to a train schedule which defines the arrival and departure of every train at every important point upon the system. Such a schedule, however, can be carried out only after the tracks, terminals, yards, and stations have been laid out strictly in accordance with the requirements of the schedule itself. In other words, a routing diagram must be made of the entire system, based upon the series of schedules that it is proposed to establish. If a certain degree of flexibility can be provided for, this of course must be taken advantage of; but in any case there will be certain well defined conditions such, for example, as the location of sidings, distributing yards, etc., if it is a single-track line. This is a well recognized principle in railroading and is fundamental to the operation of practically all systems both large and small. The only reason that it has not been recognized as of almost equal importance in industrial work, is because an industrial plant *can* operate without any clearly defined schedule, and therefore without any carefully prearranged layout or routing plan. It is not a matter of the physical safety of those who own a plant or are employed as operators, although it may well be one of life or death insofar as the well-being of the business as a whole is concerned. Industrial managers now realize, as they never have before, that the scheduling of their work is one of the prime factors of economic production, and that operating expenses can be minimized only when the plant has been physically arranged in accordance with the requirements of the most efficient schedule.



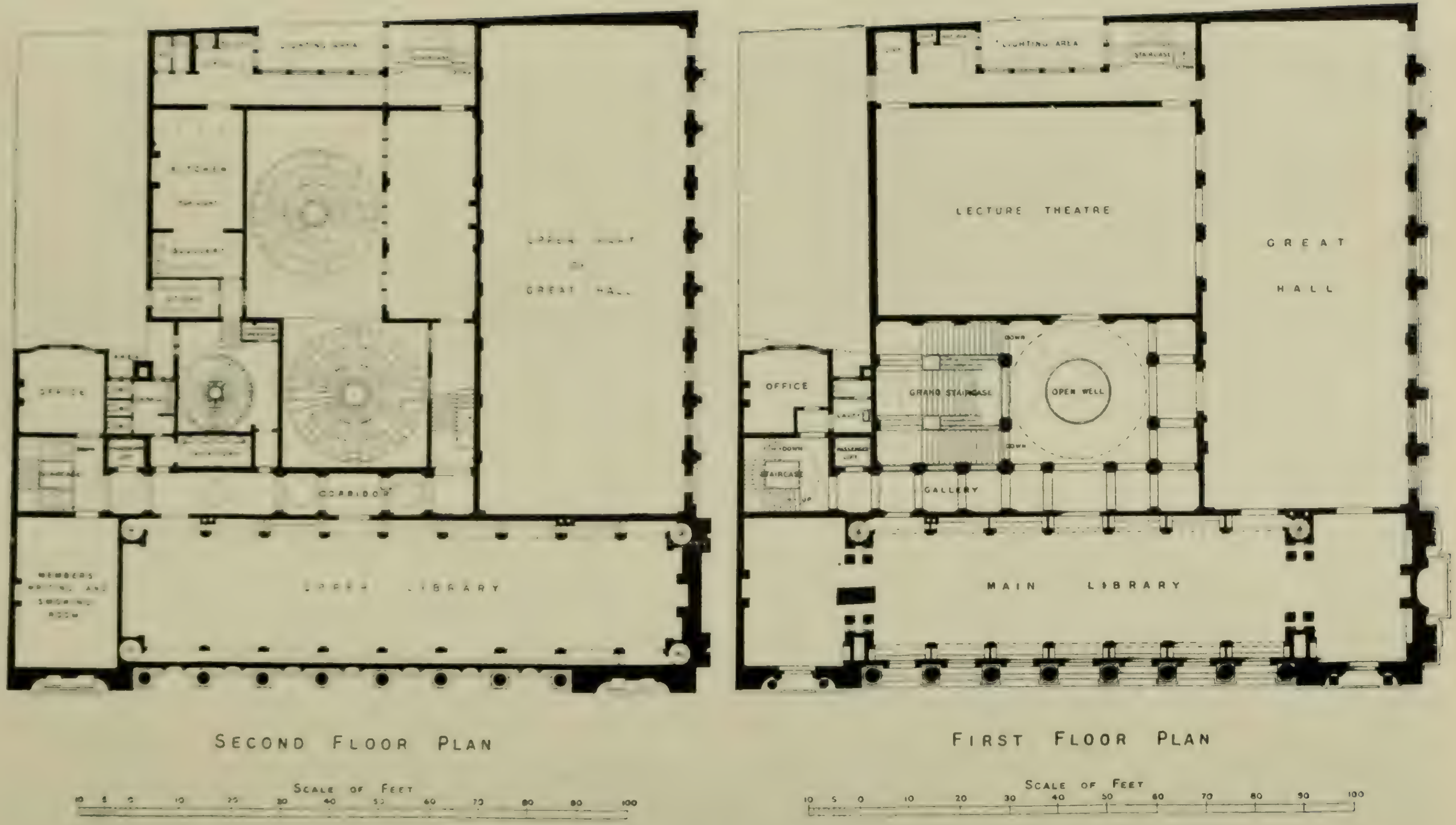
THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS. VIEW FROM ST. JAMES' PARK.

THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS.

THE perspective elevation opposite and the floor plans below and on page 824 give an idea of the new building of the Institution of Civil Engineers, designed by Mr. James Miller, F. R. T. B. A., to replace the premises at 25 Great George St., now required for the extension of the Government offices.



GROUND FLOOR PLAN



SECOND FLOOR PLAN

FIRST FLOOR PLAN

UPPER FLOOR PLANS OF THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

V. THE FINANCIAL ASPECTS OF HYDROELECTRIC UNDERTAKINGS.

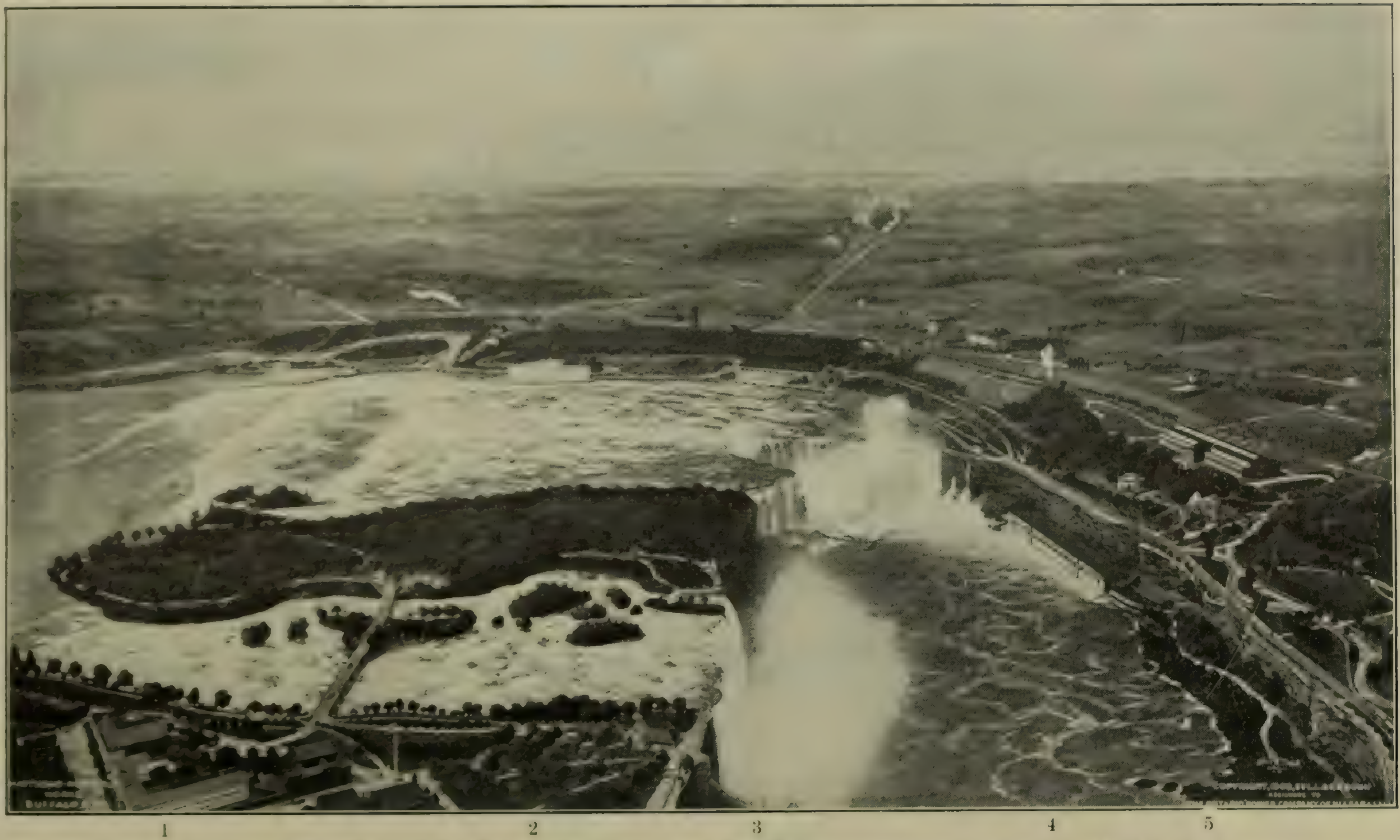
Mr. Koester here concludes his series begun in April last. Having had early and broad European training in connection with various kinds of power developments for Europe and Asia, and having been associated with many such engineering enterprises in the United States, Mexico, and South America during the past ten years, he is well qualified to give sound opinions as to the fundamental requirements and the state of the art, and their application in the important field of hydroelectric development and the conservation of natural resources.—THE EDITORS.

HAVING covered in preceding papers the design, construction, and operation of complete hydroelectric plants, from the harnessing of water to the delivery of electric current to the consumer, it remains to close the subject with an addendum on the financial aspect of water power developments and their electric utilization.

Progress in the development of engineering enterprises of all kinds is stimulated by the interchange of ideas and the knowledge of what is being done the world over. As it is recognized among the leading engineers that Europe abounds in hydroelectric developments it is doubly important that the engineer shall be familiar with foreign practice.

In Europe the limited coal supply early induced the utilization of water resources, and the various European governments encouraged the movement by granting favorable franchises.

As emphasized in the first paper of this series, America is a land of unlimited possibilities, is rich in natural resources of all kinds, including water-powers, and as our engineers always strive to produce engineering work at a record-breaking rate, the United States naturally leads all countries in water-power projects on a large scale. Great financial resources being at hand, it is possible to secure great results in a limited space of time, and this is done in order to place the proposition on a paying basis as quickly as possible, frequently regardless of real economy. This sacrifice is due to the fact that many engineers do not take the time to ponder over the many small details upon



GENERAL VIEW OF NIAGARA FALLS, SHOWING THE POWER DEVELOPMENTS ON THE CANADIAN SIDE.

1, Intake, Ontario Power Co. 2, Electric Development Co. 3, Canadian Niagara Power Co. 4, Power House, Ontario Power Co. 5, Distributing Station, Ontario Power Co.

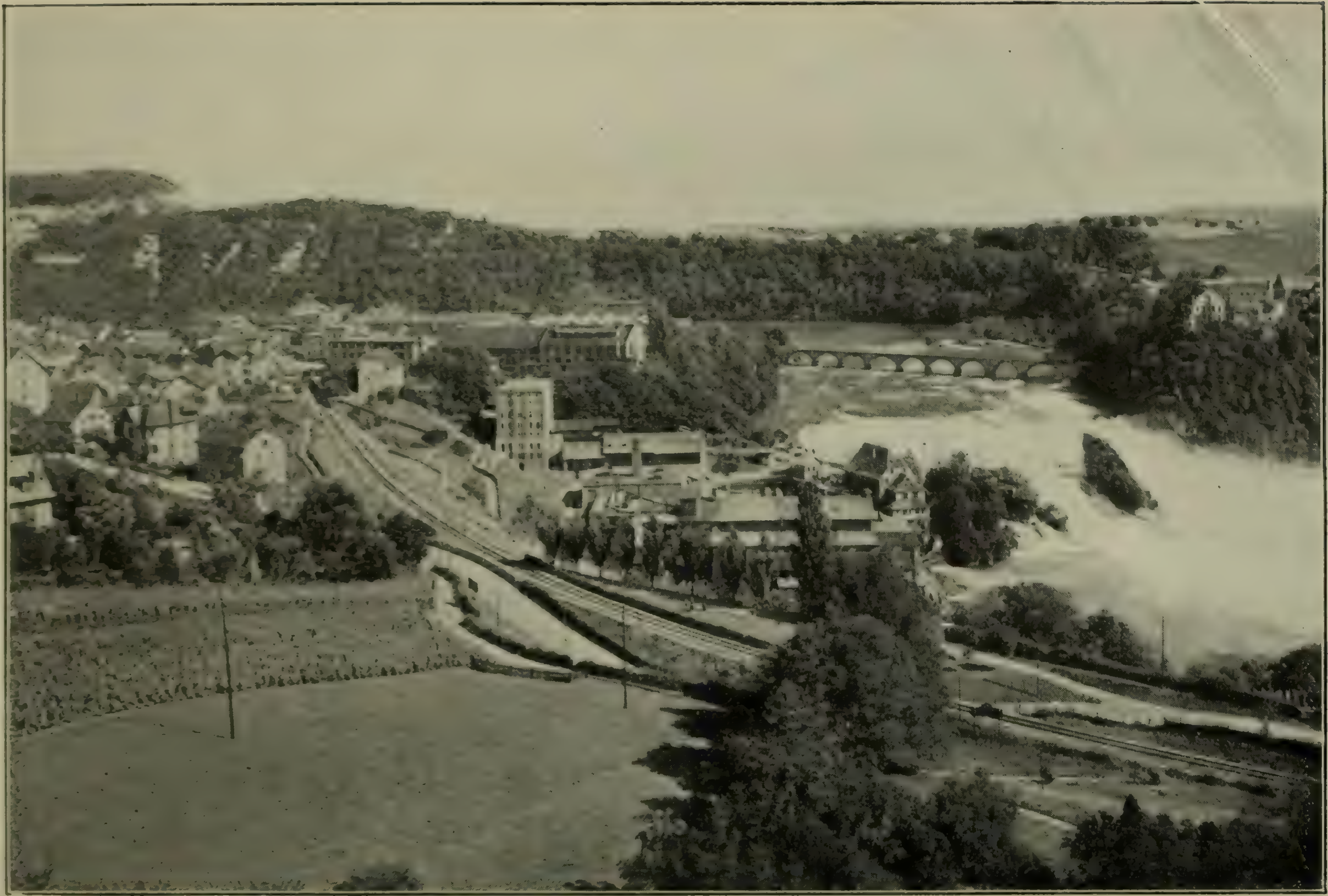
which the final success of the proposition from a financial standpoint usually depends, and have not that universal knowledge to use as a starting point and to build upon in the planning of great projects, so that future overhauling and remodeling may not be necessary.

In connection with water-power developments much preliminary study is necessary as to the drainage area, the possibility of collateral enterprises and projects (such as irrigation, or waterways for navigation, river regulations and city water supply), the present and possible future market for power, and further the possible secondary power developments. With the aid of expert engineers these matters can be properly and definitely determined. Capitalists or corporations having need of such services should first make thorough investigation as to the responsibility and actual reputation of the consulting and contracting engineers. It happens only too often that capitalists employing engineers for carrying out a project do not again engage the same men for their next proposition, the reason therefor probably being a lack of thorough investigation before giving them the first commission.

As the financial success of any project depends largely upon the ability of the engineer and his staff, it is equally important to extend the investigation in this direction. This applies particularly to those engineering firms which are obliged, because of lack of continuity of their commissions, or for other reasons, to make frequent changes in their staff. Many instances have occurred where, during the progress of the work, the engineer in charge or his principal assistants, for some reason or other, have left the employ of the concern. The effect of such interruption in the progress of the work may readily be appreciated, and the trouble is usually due to a lack of management or generalship on the part of the engineering firm. Often, for this reason, the first cost is excessively high, the efficiency and economy in operation do not meet the expectations, and the enterprise is a failure financially. This condition cannot be easily remedied. It is sometimes effected, however, and then at great cost, after the plant has been in operation for a year or more. This of course may be defined as experimenting pure and simple, at the expense of the capitalist, and this can be avoided only by employing consulting engineers in the first instance who have broad knowledge and experience.

Combination Developments.

In many instances correct advance calculations might show that a proposition would be more financially desirable, if a combination system formed the basis of the scheme. For instance, a hydroelectric



AN INDUSTRIAL TOWN ON THE FALLS OF THE RHINE. OWES ITS EXISTENCE AND ACTIVITY TO HYDROELECTRIC DEVELOPMENTS, WITHOUT DESTRUCTION OF NATURAL BEAUTY.

development might be incorporated with a proposition for the water-supply of a city, the power plant being so situated that the discharge water from the turbines has sufficient head to supply, by the gravity system, a town or city with its water requirements. In some cases this might mean that some of the available head may be lost to the turbines. In other cases, where there is an abundance of water, that for the city supply may by-pass the power house, or the discharged water may be pumped for city purposes.

An ideal system which may be developed in the interest of smaller cities, is to utilize the water power for supplying electric light and power as well as for the regular supply of water to the city.

Many of our arid sections, particularly in the western States, require systems of irrigation and such projects in connection with the prior utilization of the flow of water of a stream for power purposes would be often desirable and would form the basis of an economical proposition considered from a financial point of view. Here again the power house may be so situated that sufficient head is left to allow the discharge water to be distributed for irrigation over the surrounding section; or pumping stations using the electric current for driving the pumps may be located at suitable points. This scheme of pumping will make the proposition an economical one, as the pumping will be done at such times as the load at the power house is lightest, namely, in the summer time when a minimum amount of current is necessary for lighting purposes.

In order to protect the surrounding country against floods, river regulations often provide for changing the course of a stream and often also for raising the bed of the stream, and in both instances advantage may be taken, where possible, of the additional head which may be secured at a certain point, by utilizing such head for generating current.

In a farming community the county might utilize a hydroelectric development for supplying, from a central station, the power needed for farming on a modern and scientific basis, or a number of farmers may be interested in the promotion of such enterprises, utilizing the power in common for the purpose of carrying on their farming operations, including the lighting of farm buildings and dwellings. Electric power may be readily applied with the use of motors to all agricultural machinery such as plows, reapers, mowing machines, pumps, threshing machines, fodder cutters, feed grinders, washing machinery, creamery appliances, refrigerating installations, etc. By the use of electric light on the farms greater efficiency and cleanliness

LAKE POSCHIAVO. A NATURAL RESERVOIR WHICH IS SIPHONED AND DEVELOPS ABOUT 75,000 HORSE POWER, AT 1,300 FEET HEAD, THROUGHOUT THE YEAR.

is secured all around, fire risk is diminished and insurance rates are reduced, and the working day is not shortened in the winter season.

The great cry has for some time been raised that a livelihood cannot at present be made on the farm. The great problem is to produce more per acre and to make the laborer's position on the farm so attractive that he will be willing to remain there. It is my opinion that a good reason for the retrogression of the farming industry is that all modern engineering ability has almost exclusively been directed to the advancement of industrial enterprises, and has almost entirely neglected farming and agricultural work. Financiers and promoters will no doubt find this a great field, particularly as with the use of electric power many by-products of value may be produced commercially on farms, such as alcohol, starch, etc., from the surplus products.

A further great and promising field for the utilization of electric current is opened by the use of electro-chemical processes which will make profitable the development of many water-powers that otherwise would not be so, and water-powers which now have no available market will be made valuable. Processes not requiring a continuous supply of current will permit the utilization of power during otherwise light load periods. This would include the manufacture of air nitrate for fertilizing purposes, which field is beginning to open up.

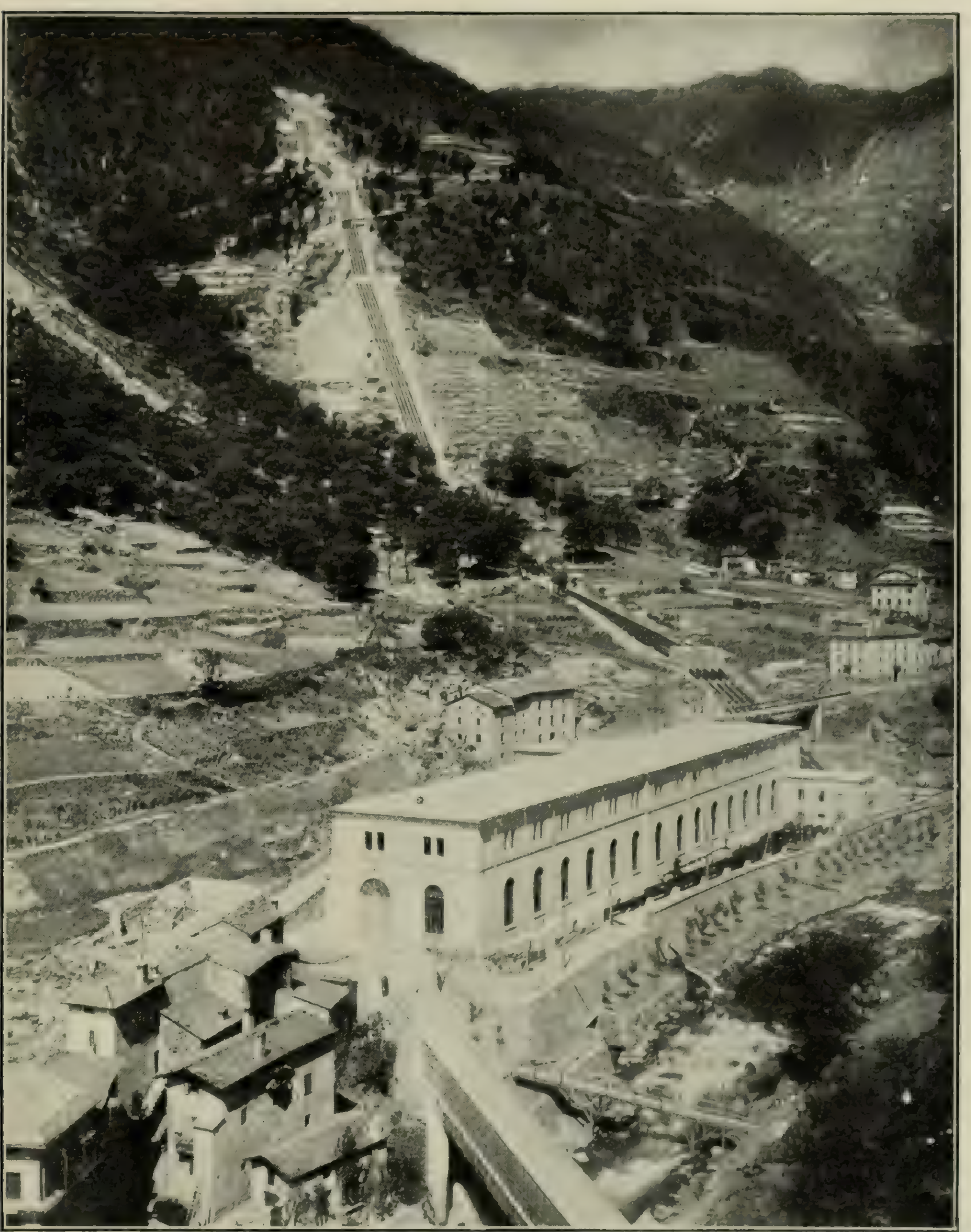
Water Storage.

There are many large hydroelectric propositions which would not warrant the expenditure, at the start, of that amount of capital necessary to build a dam of such size and character as would meet the ultimate requirements, or to develop fully the water-power in question, and the demand for current may not require it at the start. Proper investigation will determine as to how such power may be developed in stages without the investment of a very much larger sum than would be necessary to complete the final dam at the start.

This might be accomplished by building the dam to a certain height, making all provisions for increasing the height to take care of the volume of water to be ultimately impounded. Another method consists in impounding the water in stages by building smaller dams at different elevations, providing the profile of the river will permit of this. In the latter case the possibility might arise that a number of power houses might have to be provided, depending upon the number of stages of development; or this might be accomplished with these several dams by employing long pressure pipes leading to a common central power plant. Investigation must show which plan should be adopted from the financial point of view, bearing in mind that in some instances several smaller dams might cost considerable more than one large one. The skill of the engineer will determine which plan is the most economical.

INTERIOR OF THE FIRST GREAT HYDROELECTRIC STATION AT NIAGARA FALLS.
An excellent example of commercial success.

A method recently introduced on the Continent of Europe, where coal as well as water-power is scarce, and where the current can be disposed of at a remunerative rate, consists in using the discharge water over again by pumping it back, during periods of light load, to the reservoir by means of a centrifugal pump mounted upon the same shaft with the generator or driven by a separate motor. This latter arrangement has a certain advantage, in that the main turbo-generator set is cut out entirely when the pumping is done, while in the former case, when the water to the turbine is shut off, the generator will automatically start to work as a synchronous motor to operate the pump. Some years ago when the natural water-power resources were not so restricted, such a proposition would not have been considered economical as the re-impounding would be done at a considerable loss of energy, it being borne in mind for one thing that the efficiency of a centrifugal pump hardly ever exceeds 75 per cent. Add to this



BRUSIO. A MODERN SWISS HYDROELECTRIC PLANT, TRANSMITTING POWER FOR MANUFACTURING PURPOSES TO ITALY.

the loss in the generators or motors and the friction in the pressure pipes, and last and most important the power required to lift the water back to the reservoirs, and it will be seen that to determine this proposition to be a paying one, very fine preliminary calculations are necessary.

Cost of Hydroelectric Developments.

The cost of hydroelectric developments depends upon many conditions, such as water right, real estate, right of way, the cost of the

UPPER FALL OF THE YOSEMITE, 1,600 FEET HIGH.

development, and the distribution system. Further, the depreciation, repairs, taxes, insurance, interest on the investment, operating expenses, etc., enter into the account.

The cost of the enterprise depends very much on the character and the conditions under which the development is carried out, and the cost per unit capacity depends upon the total capacity of the plant. It occurs quite frequently that the unit cost in large propositions is greater than in small ones, although it would appear that it should be smaller. This is due to the fact that in many large propositions a heavy expense is involved in the harnessing of great volumes of water.

Table I, accompanying, gives figures on the estimated costs of various developments tabulated by the Ontario Hydroelectric Power Commission, while Table II gives the estimated cost of a hydroelectric plant at Niagara Falls, as given in the report of abovenamed Commission.

TABLE I.—ESTIMATE OF COST OF VARIOUS DEVELOPMENTS.

Location of Development	Nat'ral Head	Available Head	Power Developed h. p.	Estimated Capital Cost	Cost per h. p.
Healey's Falls, Lower Trent River	—	60	8,000	$675,000	$84.38
Middle Falls, Lower Trent River	—	30	5,200	475,000	91.37
Rauney's Fall	—	35	6,000	425,000	69.67
Rapids above Glen Miller	—	18	3,200	350,000	109.38
Rapids above Trenton	—	18	3,200	370,000	115.63
Maitland River[1]	—	80	1,600	325,000	203.12
Sangeen River	—	40	1,333	250,000	187.53
Beaver River (Eugenia Falls)	—	420	2,267	291,000	128.28
Severn River (Big Chute)[2]	—	52	4,000	350,000	87.50
South River	—	85	750	150,000	153.33
St. Lawrence River, Iroquois, Ont.	—	12	1,200	179,000	149.16
Mississippi River, High Falls, "A"[3]	—	78	2,400	195,000	81.25
Mississippi River, High Falls, "B"	—	78	1,100	123,000	181.82
Montreal River, Fountain Falls, Ont.	—	27	2,400	214,000	89.16
Dog Lake, Kaministiquia River[4]	347	310	13,676	832,000	61.00
	347	310	6,840	619,700	91.00
Cameron Rapids	39	—	16,350	815,000	50.00
	39	—	8,250	600,000	73.00
Slate Falls	31	40	3,686	357,600	97.00
	31	40	1,843	260,000	141.00

(1) Dam rather expensive. (2) Head works and canal less expensive than ordinary. (3) With storage development. (4) Including 3,500 feet of headwater tunnel.

TABLE II.—ESTIMATE OF COST OF HYDROELECTRIC PLANTS AT NIAGARA FALLS

	24-Hour Power Capacity		
	50,000 h. p. Development.	75,000 h. p. Development.	100,000 h. p. Development.
Tunnel Tail Races	$1,250,000	$1,250,000	$1,250,000
Headworks and Canal	450,000	450,000	450,000
Wheel Pit	500,000	700,000	700,000
Power House	300,000	450,000	600,000
Hydraulic Equipment	1,080,000	144,000	1,980,000
Electrical Equipment	760,000	910,000	1,400,000
Transformer Station and Equipment	350,000	525,000	700,000
Office Building and Machine Shop	100,000	100,000	100,000
Miscellaneous	75,000	75,000	75,000
	$4,865,000	$5,900,000	$7,255,000
Engineering and Contingencies	485,000	590,000	725,000
	$5,350,000	$6,490,000	$7,980,000
Interest, 2 years @ 4%	436,560	529,584	651,168
Total Capital Cost	$5,786,560	$7,019,584	$8,631,168
Per Horse Power	$114	$94	$86

It will be noticed by reference to Table I that the cost of hydro-electric plants per horse-power, varies greatly (from $61.00 to $203.00) and may vary even more. Correct estimates can be arrived at only by thorough investigation of all the factors, considering with especial care the important element of depreciation.

THE COST OF POWER.

In estimating the cost of power (that is, the generation and distribution, which of course depends very much upon the load factor) administration and operating expense, maintenance, depreciation, interest, insurance, etc., must also be well considered. The following table clearly illustrates the cost of power at the development of the Chicago Sanitary District System.

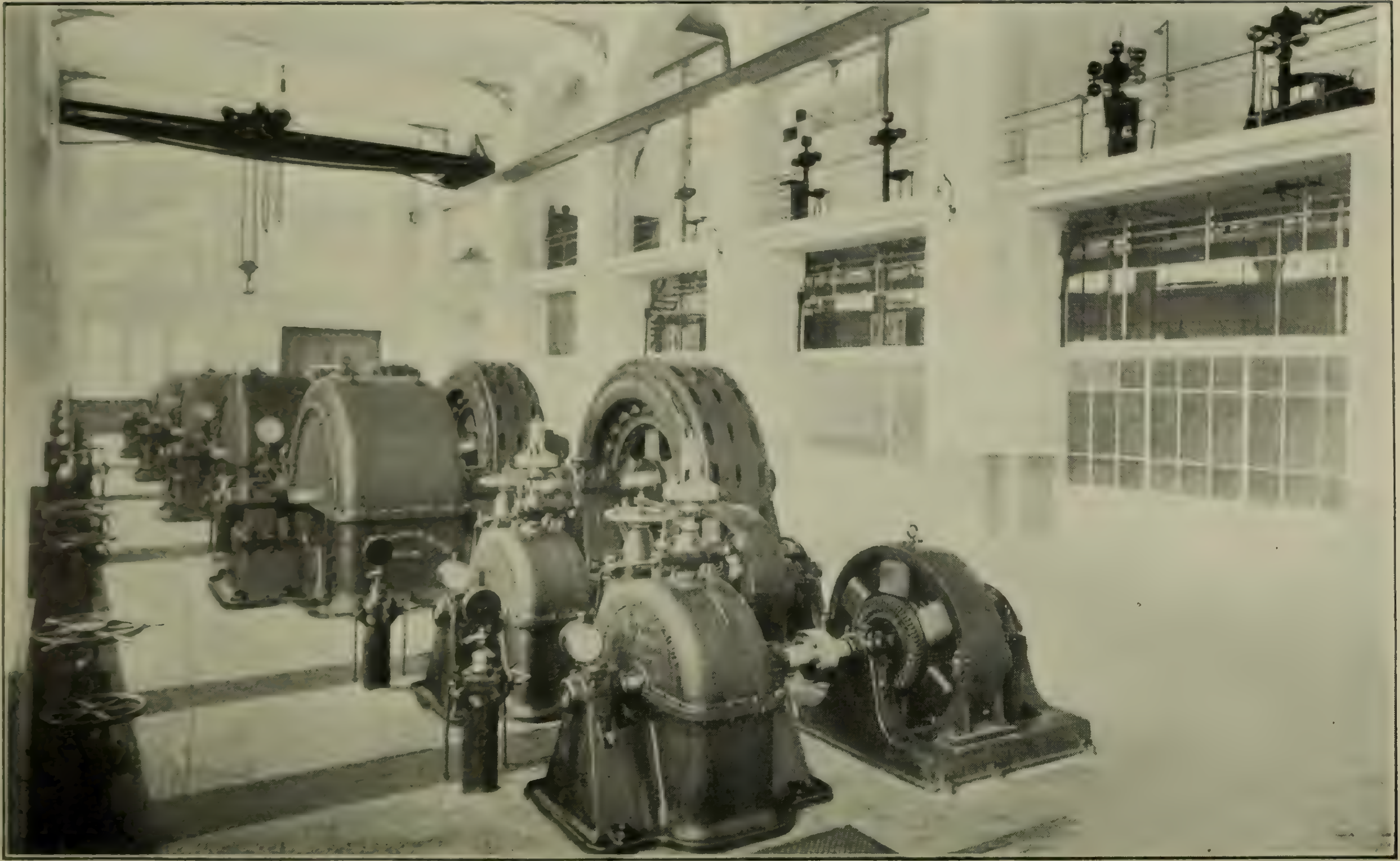
TABLE III.—COST OF POWER, CHICAGO SANITARY DISTRICT SYSTEM.

Total Cost of Development and Transmission		$3,500,000
Estimate of Cost.		
Interest on investment at 4 per cent	$140,000.00	
Taxes on Real Estate, Buildings, etc	7,200.00	
Depreciation of Buildings at 1 per cent	3,650.00	
Depreciation on Water Wheels at 2 per cent	2,027.32	
Depreciation on Generators at 2 per cent	1,824,60	
Depreciation on Pole Lines at 3 per cent	2,020.50	
Depreciation on other Electrical Appliances at 3 per cent	3,995.52	
Total fixed charge		$161,137.94
Operating Expenses.		
Power and Substation Labor	$63,240.00	
Repairs to Machinery and Buildings	3,700.00	
Incidental Expenses	1,200.00	
Operating Lawrence Avenue Pumping Station	43,960.00	
Operating 39th Avenue Pumping Station	120,380.00	
Interest on Investment 39th Street Pumping Station	15,599.76	
Total Operating Expense		248,079.76
Total Cost to Sanitary District		$409,217.70
Capacity, 15,500 h. p., Cost per h. p. per annum		$26.40

A most important item in determining the cost of power is the cost of distribution. This is particularly true in long-distance transmission systems where the skill of the engineer is of vital importance in selecting the proper route and the kind of systems to be employed.

Whether a long-distance power transmission project will pay will depend upon the cost of generating the power, the cost of trans-

AN UNDEVELOPED MEXICAN WATER POWER—SALTO GRANDE, 740 FEET.
The hydroelectric plant from which the power already developed here is obtained operates under 1,400 ft. head, generating 50,000 horse power for 170-mile transmission.



A MODERN CONTINENTAL HYDROELECTRIC STATION SUPPLYING A CITY OF 150,000 WITH LIGHT AND RAILWAY POWER.

mission, the transmission loss, etc., and the value of energy at the point of distribution, i. e., the cost at which energy might be generated at this point by some other system as, for instance, by a steam power plant. The difference between the cost of power at the generating end and its value at the point of distribution represents the maximum cost of transmission allowable.

The cost of steam power plants varies from about $75 to about $125 per kilowatt capacity, or from $50 to $83 per horse power, and the following table, IV, taken from the author's work, "Steam Electric Power Plants," represents fair average figures per kilowatt capacity, aggregating $104.50, or $70 per horse power. Steam plants can be and have been installed, under favorable conditions, as low as $50 per horse power, and have cost as high as $100 per horse power. This of course represents only the first cost of installation and does not cover the item of real estate and right of way.

TABLE IV.—COST OF STEAM-ELECTRIC POWER PLANTS.

Excavation and foundations	$5.00
Buildings	20.00
Condenser water tunnels	3.75
Flues and smoke stacks	3.50
Boilers and stokers	12.00
Superheaters	2.25
Economizers	2.25
Coal and ash-handling systems	3.00
Blowers and conduits	1.50
Pumps and tanks	1.25
Piping systems	5.00
Engines	22.00
Condensers	5.00
Exciters	1.00
Generators	12.00
Crane	.50
Switchboard equipment	3.50
Miscellaneous	2.00
Total per kilowatt capacity	$104.50

In figuring the cost of power in such plants still further items must be taken into consideration such as coal, boiler-feed water, (which in many instances must be drawn from city mains,) the greater cost of lubrication and also of repairs, larger pay-roll, increased insurance and taxes, and larger item of depreciation, as compared with hydroelectric plants.

MARKETING ELECTRIC CURRENT.

The finding of a proper market for light and power is of as great importance as the development of the plant, and this feature must therefore receive prompt consideration so that a proper load factor exists at all times. As the bulk of the demand for current is for stated hours of the day, a market must be at hand and secured for the furnishing of current during the periods of the day when the load is light. This influences the fixing of rates which must be charged for current. The greater the market, and therefore the greater the product, the lower the rate which may be charged for current and still insure sufficient net income to meet interest charges, amortization and dividends.

In the fixing of rates for cities, where public franchises have been granted to the company, two principles are involved, viz: First, the company has been granted certain privileges by the public for the purpose of enabling it readily to render some kind of service to the people, and it is to be expected that the company furnish such service as fits the needs of the people and at prices which are reasonable taking all conditions into consideration; second, the company must not be harassed in any manner but should be offered every reasonable opportunity for conducting its business economically so far as giving the service for which the company was organized, and this is being more and more appreciated by the public bodies which control such affairs. The company must be allowed to make a clear profit for its service such as will attract the best talent for its management and allow it to maintain a stable credit with the investing public.

A semi-public corporation cannot do business on the usual margin of general manufacturing profit. Such corporation, instead of making a gross annual income equal to or exceeding the capital investment, ordinarily must expend a sum in establishing its plant and business which is several times the possible annual gross income.

As already indicated throughout these papers, it may be said in conclusion that the fundamental requirements for any water-power development are an efficient source of water supply, a market for electrical current, and the necessary capital; and, in all cases, to determine as to whether the proposition will be financially successful, a thorough preliminary investigation by an engineer of broad experience with a full knowledge of what has already been done in this field is necessary, as promotors, financiers and investors must depend largely upon his investigations and reports. Furthermore, the success of the enterprise will depend not only on the scheme selected, but also upon the ability and experience of the engineer in carrying out the design and construction of the complete hydroelectric development, including all collateral enterprises.

THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington Emerson.

IV. THE SECOND PRINCIPLE: COMMON SENSE.

Mr. Emerson's current series began in our June issue. The introductory article was a brilliant demonstration, from historic examples, of the power of certain principles of efficiency. His second paper showed the unsuitability of the ordinary organization for the introduction of these efficiency principles, and indicated the nature of the changes necessary to permit their application. In our August number he reached the "Twelve Principles" themselves, and took up the first—"Clearly Defined Ideals." The present chapter is a striking statement of far-sighted philosophy, practical in the highest sense in its application to the individual, the corporation, the nation. It is a fine example of the best that engineering literature affords.—THE EDITORS.

DARWIN points out that the maternal instinct makes a mother exaggerate the importance of her offspring, thus adding to its chances of survival. Each of us is quite sure he possesses all the common sense needed, and this is also an important instinct, since without it we would lack self-confidence, initiative, we would be deficient in the ability to do, to accomplish. Before the human being runs, he walks, before he walks he creeps, before he creeps he kicks, and the sprawls of the infant give us promise of the man. Let us therefore concede to each mother that her baby is the most valuable ever born, let us praise the excessive and ill-directed activity of the growing boy. Let us also believe that no one is deficient either in quantity or quality of a form of common sense essential in past decades, but now doubly dangerous, since it not only stimulates activities that are becoming in the highest degree deleterious, but it prevents us from preparing for the dawning era in which brains and hand-skill will take up the work begun with boldness and lusty kicks in our exuberant youth.

It is because I have an abiding faith in the destiny both of my country and its inhabitants that I urge the application to its affairs of efficiency principles. That its people has in the past abundantly made use of a high order of *near* common sense justifies the belief that in the future it will surpass other nations in the use of supernal common sense. Let us therefore grasp the difference between the two, and, having grasped it, let us wake up to some of the principal present stumbling blocks in our national, corporate and individual paths.

The surf rider in Honolulu, who, standing on a board, comes in on a curling breaker, is daring, skilled, and intensely alive to the swirls at his feet. He is a good navigator of his kind; but there are men who guide great ships by noting the revolutions of the log, by marking the tick of the chronometer, correcting both by the movements of the planets and the stars. It is by these men, not by the surf riders, that the great business of the world is carried on, but the youthful surf riders of today are to become the guiding captains in the next decade. The common sense of the American is the alert common sense of the surf rider. It is not yet, either nationally, corporately, or individually the common sense of the far-knowing captain on the bridge, and what we need is not more common sense or more alertness, but a diametrical change in our point of view. The boy must forget his surf skill for a while and go to the mountain top and learn to know the stars so that he will hold them as friends whatever sea or desert he navigates or traverses.

A single red copper cent seemed of more worth to the small and terrified soul of a New England statesman than all our splendid country west of the Rocky Mountains, and because he had near common sense, he was willing to sacrifice anything to New England fishing interests; because he was destitute of supernal common sense, he lost to us the empire lying west of the Rockies north of 49 degrees up to 54 degrees 40 minutes, and, no thanks to him, we did not also lose Oregon and Washington.*

Happily there were others, earlier and later, Spanish captains, French gentlemen and French priests, American pathfinders, who in duty, necessity and joy used ice floes as ships, rode the river currents as steeds, wielded the forest fire as an axe, dynamite and mountain torrent as a shovel, until we have got into the habit of trusting to gifts, not trusting to ourselves, of deputizing the fight from our own hands and muscles to vast steam and machine equipment. And while we appropriate these titanic helps, gifts, and implements, we childishly squander our national resources in exchange for perishable luxuries supplied us by older and wiser men, corporations and nations who, not having gifts and prodigal equipment, still use their brains and hands—men who trade us sunshine, water, and air for our mined wealth, for our soil's fertility.

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* "What do we want of the vast, worthless area, this region of savages and wild beasts, of deserts of shifting sands and whirlwinds of dust, cactus and prairie dogs? To what use could we ever hope to put these deserts, or these endless mountain ranges, impenetrable and covered to their bases with eternal snow? What can we ever hope to do with the western coast of three thousand miles, rock-bound, cheerless and uninviting, with not a harbor in it? What use have we for such a country? Mr. President, I will never vote one cent from the public treasury to place the Pacific Coast one inch nearer Boston than it is today." (Part of Daniel Webster's speech in Congress in 1844 against an appropriation of $50,000 to establish mail communication with the Pacific Coast.)

At the present market price of nitrogen, phosphorus, and potash, every pound of cotton that leaves our shores carries with it about $0.03 of soil value, every bushel of corn or wheat carries away about $0.20 of soil fertility. The nominal profit, about $0.03 a pound on cotton, about $0.20 a bushel on grain, is no greater than the market price of what is taken from soil value, and our agriculturist is devoting his great activity, his strenuous life of long hours, to the spending of his capital. The net income is nil.

In the industrial and financial world our four greatest living Americans, all men of extraordinary genius and ability, are: Andrew Carnegie who built up his gigantic fortune by coverting into iron and steel, and marketing them, the national resources in iron ore and coal; James J. Hill, who has capitalized his ability to stimulate the exhaustion of the northwest wheat fields and the Pacific Coast forests; J. Pierpont Morgan, who has marvelously stimulated and financed most of the great corporations existing for the destruction of inherited resources; John D. Rockefeller, who has carried good and cheap light into the hovels of China, of Africa, but who has poured out of America by barrel, by case, and by tank steamer, our lakes of petroleum that it took millions of years of sunlight and earth's internal heat and chemistry to accumulate.

We are nearly all of us engaged in similar work, and as has been said of babies, if our ability to exhaust and destroy were commensurate with our proclivities, the United States would before now have become an emptied shell.

The civilized European and Asiatic national policies are wholly different. They regard us much as the thrifty purveyors of amusement and debauchery regard the recent notorious paranoiac who squandered his inherited patrimony abroad, doing nothing of value with either hand or brain, sweeping all the glassware from a bar in a spirit of wanton destruction, oozing gold to those wiser and more cunning, more active in brain and body than himself, until broken in fortune, mind, and body, he ends his days in an asylum for the criminally insane. What a contrast between this man and the great European artists, Sarah Bernhardt, Paderewski, Caruso, and Génée, who, inheriting no fortune and with no equipment, depleting no national resources, using only brain and muscle, exchange their fleeting efforts for half a million American dollars apiece, which they take back to their native countries whence it flows again to us in exchange for our irreplaceable products.

Does the American paranoiac differ much from the American State of Nevada which a generation ago, in its golden youth, took $300,-

000,000 in gold and silver from the ground, exported it all for transitory equivalents, and then lapsed into a sparsely settled desert waste?

Switzerland was to Europe what the western deserts were to North America, a region destitute of national resources, but for centuries the canny Swiss marketed the fighting skill of their sons, who hired out in companies as guards for kings like Louis the XVI of France or as gateway guards for private palaces, until in French the word "Swiss" has come to mean "front-door custodian."

When the French revolution curtailed the opportunities for defending kings and palaces, the Swiss started in to market their wild scenery, to this end building good roads and good hotels, making visitors from all over the world come to their country. Up to this time the taste of the educated had been for flat, formal, conventional and tidy landscapes, mountains being held in horror. The Swiss also began to market little blocks of lumber for their weight in silver (after they had carved them by hand and brain skill). They imported raw materials from $20 a ton up, and they exported them again as watches worth from $32,000 to $16,000,000 a ton, the difference between import value and export value being Swiss brains and handicraft. A very high order of supernal common sense animates the Swiss.

No wonder that the former Senators from Nevada, Stewart and Jones, with their lives intertwined into a stupendous example of collective prodigality, experiencing in their own fortunes and activities its effects, studied more deeply the inter-relation of man, national resources and money than all the professors and statesmen of the eastern seaboard! Nevada can teach us more than one lesson. It was in Nevada that two pugilists, one black, the other white, by one hour's strenuous brain and body work before a moving-picture camera, produced pictures with a net export value of $100,000. We can achieve in America when we wake up, and if two of our citizens, Johnson and Jeffries, can manufacture in two hours' time export value worth $100,000, yet not deplete our natural resources, could not some of our other citizens of higher moral, mental, and financial equipment use a higher order of common sense and develop for export other products of American hands and brains? The depletion of Nevada was a very high order of near common sense. The production of exportable films of a prize fight is a very low order of supernal common sense.

There is another Johnson, Eldridge Reeves Johnson, one of the few exceptions in our millions, who, by means of a few cents worth of materials supplemented by American brain and hand skill is capturing the great singing voices, the instrumental bands, the speech of great actors, and exporting disks at $5 each to the aggregate amount of millions. All honor to this exceptional man.

The table below, made up from figures in the June, 1910, report of the United States Bureau of Statistics, shows that one-half our imports consist either of articles of luxury, as silks, wines, diamonds, or of products that do not deplete natural resources, as rubber, sugar, chemicals, or manufactures of which the value is mainly due to highly skilled labor and delicate machinery, as cotton and linen lace, works of art and skill; and that our exports consist largely of prime raw materials, which deplete our natural resources, which are produced in vast quantities by unskilled labor aided by big and rough machines.

Even as to an item like tobacco, in which imports and exports are not far apart in value, imports were 46,838,330 pounds and exports 357,196,074 pounds, more than seven times as much in quantity.

Imports.

Total Imports	$1,557,819,988
India rubber, unmanufactured	$106,861,496
Sugar	106,349,005
Silk	100,003,636
Coffee, tea, cocoa	94,242,360
Chemicals, drugs, dyes	90,964,241
Manufactured cotton	66,473,143
Manufactured fibers, linen, hemp, etc	57,624,245
Diamonds and stones	47,799,801
Tobacco, unmanufactured	27,751,279
Spirits and wines	23,384,133
Works of art	21,088,720
Earthenware, china and glass	17,574,890
Bonnets and hats	7,950,530
Toys	6,585,781
49.7 per cent. of total imports	$774,653,260

Exports.

Total exports	$1,710,083,998
Raw cotton	$450,447,243
Animals, meats, leather, furs, etc., not including fish	199,996,328
Breadstuffs	133,191,330
Mineral oils and paraffin	106,976,571
Copper	88,004,397
Rosin, etc., vegetable oils and oil cake	54,412,275
Logs and lumber	51,852,136
Coal and coke	43,589,918
Tobacco, unmanufactured	38,115,386
Fertilizers	8,700,640
68.7 per cent. of total exports	$1,175,286,224

The exported materials, oils, metals, coals, can never be replaced; the exported lumber cannot be regrown in centuries. The imported silk, sugar, coffee, wool, tobacco and wines consist of brain skill, hand skill, sunlight, air and water; the chemicals are often high priced by-products which we waste; china, glass and laces are immensely valuable compared to the materials which make them, are therefore brain and hand products. Of the ten leading imported products, diamonds alone are lasting; all the others are fleeting luxuries, eaten up, drunk up, smoked up, worn out before the year rolls around.

Germany's governmental policy is to encourage the exports of brain, labor, sunshine, air and water; there is nothing in sugar, in alcohol, but carbon, gathered from the air, but hydrogen and oxygen gathered from the rain water, transformed by the sun into beet plants, grown in fields, tilied and wielded by hand, the beet pulp being transformed by other hands and skilled knowledge into sugar and alcohol. Denmark and Holland export butter which takes nothing from the soil. The French import Asiatic silk, weave it at Lyons, and export the finished product. They export wine, by analysis 87 per cent water, 10 per cent alcohol and 0.04 per cent aroma and bouquet. Water and alcohol take nothing from the soil, but the aroma makes the wine worth from ten dollars a pound down. In the peace negotiations between Bismarck and the French in 1871 it was not the money indemnity, it was not the loss of territory, that prolonged negotiations. Bismarck bethought himself to demand 5,000 empty old champagne barrels, impregnated with the aroma, the bouquet-producing ferment, and this the French refused. They had consented to pay $1,000,000,000, they broken-heartedly gave up Alsace and Lorain, but the bouquet of their priceless wines Bismarck should not have, and in the end they compromised on five barrels. The French were instinctively governed by supernal common sense.

America had great natural resources. The man who grabbed them first and fastest reaped the greatest reward. Tonnage, quantity, became a mania, men and equipment to produce tonnage have been the supreme aim. The American who killed the most buffalo for their hides, felled the largest tree, cutting to lumber only the main stem, pastured the most cattle on free government range, scooped or trapped the most salmon by current-turned wheels or other traps, has been a *quasi* national hero. Because these deeds were done by rifle, by steam saws, by cowboy outfits, by trap devices, it has became instinctive with us to exalt "tonnage" or quantity, to exalt equipment and to underrate organization. The instinct is therefore almost invariably to over-equip and to under-organize, to work with masses and aggregates rather than with details and ideals. Give the American a ton of dynamite and a mountain of rock and he is happy.

It takes neither much intelligence nor much labor to run a tunnel into the mountain, to excavate a chamber, to fill it with explosives, to turn on an electric sparker and blow the everlasting hills into the air, afterwards washing away the debris with a hydraulic jet. It was wonderful to make hydraulic mining pay for gold contents worth less than $0.05 per cubic yard, about one ten millionth part of the material, but there was another aspect. The hillsides were denuded, the lower rivers clogged, so that the issue between the farmers and hydraulic miners of California was a burning question for many years. Yet as we have seen, the farmer is worse than the miner. We can live without gold, but we shall starve on an exhausted soil.

Everywhere and always there is tonnage mania, and with it over-equipment of plant, too many men and prodigality of material. More capital is invested than is necessary. It is the material asset that appeals, not the greater value of organization and skill. Even a further step is taken and tonnage possibilities are converted into stock. I knew one captain of finance who capitalized the uncaught fish in the sea and persuaded Wall Street to underwrite the securities.

In field, in forest, in railroad operation and in manufacturing shops there is the same spirit of tonnage mania, lavish equipment, under-organization. It is good that the farmer transferred the bulk of his manual work to animals and more recently to machines. It is not good that his farm machinery, which ought to last with care for 40 years, is used only 30 days each year, is worn out and discarded in 5 years, after a total average use of only 150 days. One-third of the cost of harvesting and threshing wheat is the depreciation of the farm machinery.

From our forests we produced, in 1850, 5,000 million board feet, in 1909, 50,000 million board feet, a total of over 1,000 billion board feet, and a like amount has been wantonly or carelessly destroyed.

Railroad officials of the highest rank and largest experience have testified to the loss of ties by decay, to the waste of fuel, to the lack of interest of employees, to the detentions of freight cars, thus indicating inefficiencies of material, inefficiencies of labor, and inefficiencies of equipment, but thus far they have not ascertained with exactitude the extent of these inefficiencies nor their cause.

When for several generations our big activities have been built up on tonnage ideals, it will be exceedingly difficult and disquieting to change the destructive tendencies, and our whole industrial organization will have to undergo sooner or later the experience of a certain large shop. The company owning it also owned large ore mines, lake steamers, railroads, coal mines, river barges. The main business was originally to make iron and steel. To this end blast furnaces, converters, were built, and to keep them busy the contributory properties were secured. Each and every part from mine to mill finds itself operating on a tonnage basis. The easiest way to reduce costs is to increase tonnage, to put into operation larger and larger equipment. Purchasers wanting thin sheets and small rods have complained to me of the great difficulty of having their orders filled. There is no tonnage in such orders; they do not help the mine, the steamers, the railroads, the coke ovens, the furnaces, the rolling mills. To absorb the tonnage, manufacturing shops are started to convert shapes and rods into finished product, bridges or bolts, etc. One of these shops was selected for the application of efficiency principles. On time-study investigation the automatic machines were found to be delivering but 30 per cent of rated capacity, although the shop was on full time. By discovery of and elimination of the causes of stoppage, the output was increased to 67 per cent and it was then ascertained that working at 80 per cent of rated capacity the shop could turn out more product than required normally by the whole United States. The shop is now working less than half time and is producing more than it ever did before on full time.

As was formerly the case in this shop, "*the immediate*" has been mercilessly held up to every one connected with American work. A generation ago, all but a few of the railroad companies capitalized maintenance and declared dividends out of imaginary earnings. The immediate obscured the future. There has been an improvement at the top, but the minor officials still exercise all their best near common sense in realizing near ideals.

A number of years ago there was a great freight blockade extending west from Buffalo. Every western superintendent was instructed to forward no more cars. A local superintendent at Buffalo had gathered from far and near all locomotives, unreliable cripples as well as good power. The blockade became worse, as the cripples hindered the good locomotives even as women and children would hinder a regiment of marching soldiers. A high official was imported who made quick work of the trouble by sending the cripples away from the field of battle. When it became apparent that the blockade was soon to be broken, word was sent west that on a certain date cars could be forwarded. A smart superintendent of a western division industriously collected all his locomotives, arranged long trains of freight cars in his yards and on his sidings, and when the hour came he forwarded an avalanche of trains and cars, clearing his own divisions, but hopelessly clogging the next one. As part of his plan he disappeared from his office so that he could not be reached by higher authority and his nefarious myopic zeal be thwarted. He made a tonnage record, he trusted to his equipment, he showed near common sense.

A railroad superintendent had occasion to send one of his locomotive to the central shops several hundred miles away for repairs. The locomotive was quite capable of hauling a two-thirds load, but this was not permitted and the locomotive was not even permitted to go under its own steam. It was put in a freight train and bumped over the road to its own detriment and that of the train and track. The superintendent was adding to his tonnage record. This tonnage mania is one of the curses of American practice. It had its value a generation ago when first erected consciously into an operating principle for blast-furnace output and freight movement by the great minds of Andrew Carnegie and James J. Hill, but it has wrought havoc when applied by lesser geniuses who forthwith, instead of thinking and planning and organizing, clamor for more equipment. The epidemic of broken rails which discredited the Bessemer process and against which railroad executives combined in protest was brought about by the tonnage mania, by the use of piped ingots and few passes. The physical and pschyical sledge-hammer blows of Mr. J. W. Kendrick demonstrated the rottenness of the rails.

On one of the great transcontinental lines a gravity grade was eliminated at a cost of $5,000,000, entailed a fixed charge forever of $1,000 a day. The operating cost of the helper locomtives able to handle all the traffic up the grade did not exceed $100 a day.

In the foundry of one of the large Pittsburg machine shops, the castings for a large engine are made. Eighty per cent of the weight and forty per cent of the work occurs in three or four pieces, the fly wheel, the bed, the cylinder. On the next fifteen per cent of weight there is another forty per cent of work, and in the final five per cent of weight there is twenty per cent of the work. The founder, aiming at tonnage, molds the big pieces and then clamors for more work, urging the starting of another engine. When the engine parts reach the erecting floor it proves almost impossible to secure the five per cent of missing small castings, involving per ton eight times as much work as the larger pieces.

A structural shop orders the supplies from a rolling mill. The big beams are promptly shipped, because they add to tonnage. The angles and smaller pieces do not come for weeks or months. The superintendent of the structural shop pleads for permission to begin work immediately on material not deliverable for three months. He also has a greedy eye on tonnage. If permitted to do the work ahead of time he clamors for permission to ship it. He is always ahead on big work, always behind on small work.

In a machine shop it is ascertained that a big machine, a flange furnace, a bull riveter, a wheel lathe, can do certain classes of work in shorter time. Very seldom is a careful study made of the yearly cost of operating and maintaining the desired machine, or of the quantity of work that can be diverted to it, or the disposition that is to be made of the displaced machines. The efficiency of the existing machines and men is never ascertained, because there are only a dozen shops in the United States in which any scientific standards of men and machine efficiency exist. The old machines may be working at 60 per cent efficiency, with a standardized cost of $0.90 an hour for machine and man. New equipment costing $10,000 is ordered. with a yearly machine rate alone of $5,000. If the machine is used 2,500 hours, the hourly rate will be $2.00 an hour. The probability is that it can be used only 1,250 hours in the year. This makes the actual hourly charge $4.00 an hour for work which had been taking twice as long at 60 per cent efficiency and at a cost of $0.90 an hour. At 100 per cent efficiency it would have taken only 20 per cent longer time than on the new machine, the relative costs varying as $1.08 on the old machines to $4.00 on the new.

In a plant a new $8,000 machine was ordered by the office because it was believed that certain work was not being delivered fast enough. It was found that the old machine was only working less than three hours a day. Had the new machine been bought it would have increased permanently the operating costs of the company about $4,000 a year.

In over-equipped plants (most plants are over-equipped) if there is an expensive machine capable of working only a few weeks each year, the work is not to be charged with the tremendous hourly rate required to carry the machine. A legitimate hourly rate is based on the assumption that the machine works full time and the idle hours are charged to overhead expense. The aggregate of these wasteful overhead expenses is very great. It is common sense, the highest kind of progressiveness, to install a machine that can cut down the time of work to one-half, and this kind of common sense is peculiarly American, but usually the increased equipment is not yet needed, existing equipment is inefficiently used owing to under-organization, and the ill considered additions are due to the national reluctance either to think or to tire muscles.

The traffic manager of a great railroad apprehends a prospective 10 per cent increase in business several months ahead. He immediately insists on additional equipment, 100 more locomotives and 4,000 more cars, and no one stops to ascertain whether existing equipment is working at more than 60 per cent efficiency. On the basis of past experience the increase is justified, but there are many instances in which equipment takes the place of business, as in the case of the boy who, starting a lemonade stand, does not feel himself equipped for business until he is provided with patent lemon squeezers, ice pulverizers, strainers, patent vibrating shakers, a $50 outfit, from which with great loss of time he produces semi-occasionally luke-warm, watery lemonade in dirty, sticky glasses. He has neither organization, ideals, nor common sense, and so, in his humble way, he tumbles into the mistake of over-equipment, carrying out the national proclivity which prevents us from giving to great industrial problems and questions as much time and analytical thought as a good chess player gives to his game.

The American, from presidents of the United States or of great corporations down to cubs in office or shop, in spite of his natural mother-wit, finds himself struggling against quicksands of tradition, whirlpools of immediate necessity, fogs of current practice, of near common sense; and each is in the condition of the great condor, the most skilled of all flying birds, whose nest and starting ledge is in the face of high cliffs, but who, once on the ground, in a fifty foot circle surrounded by a ten foot fence, is less able to rise than a barnyard chicken.

The elimination of waste through the application of the efficiency principle of common sense is a more difficult task that the elmination of waste from gold-mining operations by the use of better processes. Better extraction from ores, better exploitation of mine tailings, is easily attained by the use of better methods, which do not in any way clash with the training, ideals and conceptions of a progressive manager.

Better methods and processes, however important, are a minor part of one single efficiency principle, the standardization of conditions; but to apply all the principles, a manager must be born again, forgetting much that he thought of value, adopting, adapting, becoming adept in new lines of thought. At the start he finds himself enmeshed in an offensive, destructive type of organization which he must use an unfamiliar common sense to modify and remake into a defensive, upbuilding type. Even if he is in a position of highest authority at the top, this is not easy as he must run counter to most of the ideals and life-long practices of an extended line of subordinates. If he finds himself many steps below the top, he is indeed caught between the upper and nether mill stone, for those above him will treat his suggestions with impatience and skepticism, those below him will meet them with rebellion. Even if he succeeds in making his organization constructive, he must again use an unfamiliar common sense to overcome in himself and others a long series of vague, discordant, at best opportunist and near ideals, substituting for these, not utopian and unrealizable, but wordly-wise standards as high as the particular activity will commercially stand.

If a manager has succeeded in modifying the organization, if he has succeeded in emphasizing the governing ideal so that all may understand it and work for it, he suddenly meets new difficulties probably from both customers and government who will make the occasion of his efforts to eliminate waste, to make better use of materials, of labor, of equipment, an excuse to demand a physical valuation of the material property as a basis on which to regulate freight rates or other charges, thus imposing a direct penalty on efficiency.

It is impossible to lay down rules or to give specific directions as to how we shall convert prejudice and ignorance from without, near common sense within, into supernal common sense.

Near common sense binds to the centre of a sphere. Supernal common sense may, like a star, survey the centre from any part of the vault of heaven, but the twelve principles of efficiency, like the twelve signs of the zodiac, divide the heavens into twelve parts, thus giving us twelve different directions of attack on inefficiency.

To select an upbuilding constructive organization, carefully to determine and adhere to ideals, constantly to survey every problem from a lofty instead of near point of view, to seek special knowledge and advice wherever they can be found, to maintain from top to bottom a noble discipline, to build on the rock of the golden rule, of the fair deal—these are the general problems which supernal common sense must immediately solve. It will perhaps prove more difficult to remedy the evils of over-equipment, the direct result of an elementary organization accustomed to deal with great natural resources.

GOVERNMENT SPECIFICATIONS. AN EXAMPLE OF NEGLECT OF THREE EFFICIENCY PRINCIPLES.

By F. Percival.

The author of this article is intimately familiar with his subject. His contribution, received some time ago (in fact, shortly before the commencement of Harrington Emerson's series on the "Twelve Principles of Efficiency"), is presented as the first of a parallel group exemplifying, by independent testimony from practicing engineers in various fields, the universality of these principles and the specific effect of their observance or their neglect. The present paper points out the injury—the inefficiency—arising from non-observance of three of the Twelve Principles: Common Sense, the Fair Deal, and Expert Advice.—The Editors.

IT is safe to say that one-half of the cases before the United States Court of Claims are due to poorly prepared contracts which have their source in faulty specifications. Furthermore, not less than one-third of the cases brought before the Comptroller of the Treasury are due to the same source. When one stops to think of the great cost to the United States brought about by lack of care in preparing specifications, it seems unreasonable that steps are not taken to correct the condition.

No doubt much of the fault lies in the fact that Government specifications are prepared by inexperienced men; that is, men who lack practical business training—men who, certainly lacking the "supernal common sense" defined by Harrington Emerson elsewhere in this issue, and largely lacking even "near common sense," in their zeal to cover every point, go beyond reason in their demands. The specifications are too one-sided, and the requirements often so poorly expressed as to permit of various interpretations. It frequently happens that the successful bidder may have had one idea when preparing his bid on a certain piece of work, whereas, if a narrow-minded inspector be on the job, the contractor may be required to place the work in a manner which will cost him thousands of dollars more than the price bid. When there are commonly accepted methods for doing work, those methods ought to be specified; but if deviations are to be required that fact should be clearly stated in the specifications. This would give bidders an opportunity to prepare their bids accordingly.

Here is a case in point: A firm after submitting the lowest bid for building a power house was requested to revise its bid so as to bring the total cost within the amount allotted for the work. The firm complied; but during construction the inspectors were more than exacting in their demands, and finally, after the switch boxes, etc., had been installed according to contract, requested that the boxes be removed and new ones placed so as to meet the requirements of the State (Pennsylvania) underwriters. The contractors say that that change alone cost them more than two hundred dollars. When asked why they did not appeal, they said: "Our retained percentage would have been held up, and we needed the money; furthermore, the amount was too small to employ a representative, although it practically wiped out our profit. Instead of showing us some consideration, the inspectors put the strictest interpretation on the specifications." It is a fact that that firm always bid high on Government work thereafter—unreasonably high.

Another case was that of paving the river bank near Marietta, Ohio. In this case the specifications called for riprap, but on the drawing showing the paving in place there was noted that a corner should be cut from each stone. In getting out the stone the contractor ordered rectangular blocks in accordance with the specifications; but before he could lay them he was required to cut off a corner from each stone.

A contractor receives very little consideration in such cases. He must either accept what is allowed him, or he must sue for his rights. Of course, there is the Comptroller of the Treasury, but it is not always safe to go to him. Many contractors have the impression that it requires legal counsel to present a claim, and the amounts involved do not always justify such expense. Take the case of the switch boxes; had the contractors refused to comply with the demands, the contract would no doubt have been annulled and the retained percentage would have been "tied up" until the work was completed. Should the contract have been annulled, the Government would have either completed the work or had it completed, and the contractors would have been forced to stand any additional cost incurred. Or they could have completed the work and sued for their claim for extras. In that event they would have had to employ an attorney, and perhaps wait from three to six years for a settlement. This simply goes to show that after a man has entered into a contract with the Government, the inspectors and officers can either "make or break" him. It shows that provision should be made to compel the exercising of great care in preparing Government specifications, not only for the protection of contractors but for the protection of the Government itself. It is not believed to be the intention to have work done in excess of what the contract calls for without paying for it; but it is known that inspectors have been overzealous and have caused contractors needless expense and loss, and that they have erred on the other side also.

Often Government specifications call for grades of material, special tests, etc., that are never furnished nor asked for. Only the experienced contractor understands how to have such requirements waived; and it is those men who are successful—who make money. But even they miss it. Think of what it costs the Government when special requirements are waived—they are never waived until after a contract has been entered into. Some time ago specifications for white oak required that the timber be practically clear. There was not a bidder who did not express the opinion that such timber would be very expensive should anyone be able to furnish it at all. While the successful bidder quoted a high rate, the timber was not furnished according to specifications—it was not clear oak. Had the specifications provided for oak of the grade that was accepted, the Government would have received equally good material at a saving of at least $20 a thousand.

No Government contracts or, for that matter, contracts for any public work, should be, nor can they be, awarded as is work for some of the large corporations. Public work should be let on carefully prepared specifications, and to the lowest responsible bidder, without trying to beat down the prices after the opening of proposals as has been done by some of the large corporations. But it is imperative that all public-work specifications be carefully prepared from every point. The spelling, sentence construction, use of words, and requirements should be carefully considered in each case. Government specifications err as a rule on the side of unreasonableness—often the requirements can not be met.

How for example can such statements as the following be reconciled:

One paragraph provides "Sub-contractors, as such, will not be recognized."

Another paragraph of the same specifications provides in case of annulment of the contract "the United States shall have the right to take possession of * * * any or all sub-contracts * * * and to pay for them * * * at a valuation to be determined by the Engineer * * *. In case any * * * sub-contracts * * * are taken possession of by the United States * * * it is understood and agreed that no payment therefor shall be made until the work has been completed."

Sub-contractors will not be recognized; but without consulting the sub-contractors they must furnish material, etc., and wait for payment until the contractor's work is completed. The fact that such documents are contracts and provide requirements for each party thereto is ignored by the agents of the Government. Under what circumstances can the Government require a man to fulfill a contract without meeting the other party's obligation under the same contract? Under such a requirement would a Government agent have authority to make payment, in case of annulment of original contract, if material had been furnished under a sub-contract? If not, how would a man of small means be able to obtain payment? He could not afford to bring suit, the amount being generally too small; and he could not, without undue hardship, wait so long for payment. Such requirements are detrimental to the service.

Here is another extract from Government specifications for machinery:

> When funds are available, payments on each lot will be made monthly for material delivered at the site and accepted, as follows: 40 per cent for raw material; 70 per cent for machinery or structural steelwork ready for erection; 90 per cent for completed work; and the full amount upon completion of the contract.

How much was the contractor for the machinery entitled to under that provision? It appears that if he took advantage of each payment provided, he would receive 260 per cent; that is, 70 per cent on delivery, 90 per cent on completion of the work, and 100 per cent on completion of the contract. Furthermore, what is the "completion of a contract?" Does it mean when the contractor has completed his work; or does it mean when both parties to the contract have fulfilled their obligations thereunder? If the latter, when would the contractor receive payment?

What would be the chances for a contractor in the hands of an unreasonable inspector under the following provision:

> Incidentals; minor items of material and work not otherwise provided for; temporary work, material, plant, and tools; assumption of risks; and other expenses and losses incident to carrying on the work shall be

> covered by the rates or prices bid. Everything provided for in the specifications or shown on the drawings shall be completed, furnished with all necessary and usual accessories, and put in good condition and working order.

Would any court uphold the demand for carrying out the first part of the above provision? If not, why fill specifications with such "stuff"? It is just such requirements that keep competent and responsible men from bidding on Government work.

Uniformity in Government specifications is unknown, and as a rule those specifications are conspicuous by the absence of generally accepted understandings—trade terms. Is it impossible for the Government to adopt certain specifications for timber, iron, steel, stone, and the like? Such specifications could be standardized and would greatly facilitate work, especially in the Engineer Department of the Army. That Department has already adopted specifications for cement; but requirements of those specifications are frequently waived.

In measurements of material and work, why should the Government have different methods from those generally accepted? Do they help anyone? Take the following:

> Except as otherwise provided, measurements for unit-quantity payments will include only finished material forming part of the permanent work, actually in place and accepted.

Does not that paragraph make provision for the deduction of bolt holes in timber? For example, if a contractor furnish a stick of timber in accordance with the specifications, and holes are required for anchoring, can not the inspector make deduction for the timber removed in drilling the holes? When such provisions are made, a bidder owes it to himself to quote prices accordingly; he can never tell to what extreme an inspector will carry the matter. Would not the Government profit by following regular business practice in such cases?

It is a well-known fact that it is quite a simple matter to find errors in the work of others. But how are such errors to be avoided? By employing competent, practical men. With the large amount of work done under contract, the Government should have little or no trouble in issuing specifications under which a man can do good work at a reasonable price.

In the first place a board should be appointed whose duty it should be to consider thoroughly every set of specifications before they are issued. Such board should be made up of one man from the Department of Justice, a man from the Treasury Department, a man who is well schooled in the use of the English language, and a man from the department under which the work covered by the specifications is to be done. Business terms where applicable should be used, and the practice among business men should be followed whenever practicable. When special requirements are necessary they should be clearly expressed and adhered to. Government work should be among the best in every detail, and the Government should receive what it pays for; but it should set forth plainly and in no uncertain terms what is required. Specifications for public work should be statements of what is wanted; they should be brief and to the point; they should be models in clarity of expression.

TIME-KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

IV. OBTAINING TRUE COSTS OF CASTINGS.

Mr. Claydon's series began in May last, and has continued throughout the summer with the exception of our August issue, when it was interrupted by the illness of the author. This month's instalment concludes the discussion, which throughout is addressed to the modest establishment requiring adequate and reliable records with the minimum of clerical work and expense.—The Editors.

THE purpose of this concluding article is to endeavor to bring together, in as concise a manner as possible, the numerous divisions that go to make up our final cost reports. One might very easily fill sheets of paper elaborating each of the various items composing these reports, but my idea is rather to consolidate the information at our disposal, and set out just those pertinent facts which will give the true conditions of our costs, and enable the management to rectify any defects that may from time to time be shown up in the various reports.

In the preceding articles on labour distribution and stores I endeavoured to show how the labour and material might be consistently apportioned to the various shops to which they belong, thus making a shop burden for each department.

Before our final reports can be made up, however, there are one or two points on which it might be well to touch, and in the first place let us look at our invoices. I have previously spoken of these invoices which are debited to our stores, but in addition to those, there are numbers which can be charged either direct to our staple lines of manufacture or to the particular job on which they are used. For example, we might charge nickel door handles for furnaces directly to that account, or we might charge a steel beam to a machine-shop repair, as we are in a position to know that this particular beam was bought and used for that specific purpose, and by this means we obviate the necessity of a bulky stores ledger. When we know that a certain line of goods is bought for, and used exclusively on, any particular line of castings, it is just as well to place such invoices to the debit of that article instead of the matter having to pass through the storekeeper's hands two or three times.

It has been already pointed out that these articles are not addressed to such plants as have an elaborate system in force, but rather to the young plant which as yet has no particular system, but knows that one is required, and is consequently seeking some ideas which will give practical results without an excessive cost.

To deal with all our invoices in the way outlined hereunder will I think give us the information necessary for the apportioning of expenditures to the several accounts to which they are chargeable. As soon as any invoices are received by the purchasing agent, he should at once mark them as chargeable to certain account numbers, according to the classification of accounts we have in force. At the end of the month these invoices should all be gathered together and entered in an invoice record book, and the various items charged out in the distribution columns of this book according to the classification made by the purchasing agent. By this means our stores-ledger clerk is enabled to get the exact amount of the invoices that should go through his stores ledger for any particular month, and at the same time he can obtain the total amount of invoice burden chargeable to each shop, and charge it on his burden reports.

Another point I think worthy of consideration is the following: In order to illustrate better how errors and defects occur and are treated, let us assume that a large cored casting has been found defective, and when the piece was broken up for examination it was found that it was the moulder's fault that the casting turned out bad. In this event, presuming the moulder and core maker to be both piece-work men, although the moulder would not get paid for this bad work, yet the core maker would have to be paid, so that this amount would have to be charged to our "Errors and Defects" account. Such instances as these, however, do not constitute all our errors and defects. It happens quite frequently that even after a casting has been sold and delivered to a customer it will be returned by him as defective, for some reason which could not be detected in the shops; hence it will be necessary for us to go to our credit book each month and place in our burden accounts all the charges made against errors and defects. It will happen, perhaps, in some months that this amount will be quite a large sum, or *vice versa*. It is, however, of sufficient importance to need very careful looking after.

Having now obtained sufficient information on which to start our final cost reports, let us glance at the various reports we shall find it necessary to make in order to arrive at the true cost of our marketable product of each class of castings manufactured. Our first consideration, then, will be our Foundry Cost and Production Report, which we will divide as follows: "Cost," left-hand side of form, and "Production," the right-hand side. On the left-hand side, then, we shall enter the various grades of pig iron and scrap with the quantities of each used, extending each class out at its respective price per ton. On completion of this we have the cost of our gross melt, but this by itself is of no avail, as it stands to reason we must credit our gross melt with all the sprues and gates and bad castings made during the month, as obviously all these go back to the cupola for remelt. After deducting this amount from the cost of the gross melt we have the cost of our net metals used—or, in other words, we have that amount of money which when divided by the quantity of good castings produced will give us the price of our iron for one pound of saleable product. This, then, is our starting base. Having arrived at this cost, our next point is to enter on this sheet our direct labour on the several classes of castings manufactured, both for moulding and core making, and any other direct labour we may have in the foundry, and by dividing this total by the quantity of good castings we arrive at the direct-labour cost per pound of good castings. It must be borne in mind, however, that when working out the cost of direct labour per pound for core making, the amount must be divided by the weight only of good *cored* castings produced; hence it will be necessary for us to keep these weights separate in our "daily record of production" book.

The remaining portion of the left-hand side of our report is devoted to the several divisions of burden which we have to obtain from our foundry and core shop burden reports; but before dealing with these we will glance at the right-hand side of our form, *viz.*, "Production," and see what subject matter is required to complete this. As on the cost side of this form we started with the items composing our melt, so on this side we start with our production. From our "Daily Production Record Book" we should be in a position to obtain the total weight of each class of castings produced, both good and bad, these in turn each being subdivided into plain and cored work. These respective weights should be totalled and the totals enumerated on our production report under the respective headings of good and bad castings. In addition to these, we should also enter the weight of our sprues and gates produced. The total of our good and bad castings with the sprues and gates will therefore give us what we actually received for the amount of metal put in cupola (see opposite side of report). By deducting this total from our gross melt we arrive at our shrinkage (or loss in melting) and the whole added together will balance our gross melt.

Of course this form can be very much elaborated to suit the requirements of the management. For instance, we can add items of general importance, such as the amount of metal melted with one pound of fuel, etc.

We will now turn to our Foundry Burden Report, as it will be necessary for us to have these figures before we can complete our Cost and Production Report. In a previous article I gave the different divisions that go to make up this report—that is, the items which should be distributed on the basis of tonnage and those items which have to be distributed on the amount of direct labour expended. In September, 1909, I wrote an article for this magazine on the subject of the "Proper Distribution of Foundry Tonnage Burden," the point of which was that in order to apportion these burdens accurately it was necessary that the total burden should be distributed on the total weight of good and bad castings produced, for the reason that in the event of any particular branch of our business suffering big losses the onus would be put on that department and not spread over the other branches of our business, which had nothing whatever to do with the losses in question.

I do not think it would serve any purpose to illustrate any form on which all this subject matter can be drawn up, as with each foundry the nature of the information required varies very considerably; and these matters are best determined by the officials requiring the information. However, the theory is just the same, and with such modifications as may be deemed necessary, suitable forms could very easily be drawn up. As a suggestion of the principal burden accounts requiring careful handling the following I think are the chief: Cupola Labour and Repairs, Ladle Expenses, Renewals of Flasks, Cleaning and Chipping, etc., these being tonnage charges; and then again in our direct-labour section it will be necessary for us to keep track of such items as Maintenance of Buildings, Machinery, Tools, etc.; also general Shop Expense, which as I have previously stated can all be subdivided into any divisions found necessary in the working out of our system. In addition to these, and before our burden report can be completed, we will still have to enter what I will term our "Administrative Distribution Burden." This expense is composed of the proportion of salaries of officers chargeable to the foundry, and our proportion of the head office expenses, rent, rates, taxes, depreciation, etc., and these can be only gathered from a general burden report (which I will deal with hereafter), and then pro rated over the various shops. As soon, then, as this information has been compiled, we can carry our total foundry burden of each class of castings to our

Cost and Production Report. Our core shop being an adjunct of the foundry, it will be necessary for us to carry an adjunct of the Foundry Cost Report. (This Burden Report will contain only our core shop expenses, and will be distributed on the weight of good cored castings produced.)

Having now all our information correctly recorded, we can very easily ascertain and enter up the cost of each class of castings in the foundry (or at the machine-shop door).

Our next step then is to arrive at our machine-shop cost, and here we have no tonnage burden to contend with. From our machine-shop labour distribution (explained in a previous article) we are in a position to get our direct charges for this shop, and also the burden charges, which have to be distributed to the several classes of castings on the percentage of the direct labour on each. In all probability we shall find our machine-shop burden much higher than the foundry for the reason that we are bound to have much more indirect labour in this shop. All our pattern renewals are chargeable to the machine-shop burden, and one can readily understand that in a plant of any magnitude this is no small item. The burden report may be conveniently itemised in the following manner:

Renewals of Patterns, Wages and Materials. Maintenance of Buildings, Wages and Materials. Maintenance of Machinery, Wages and Materials. Maintenance of Tools, Wages and Materials. General Shop Expense, Wages and Materials.	Distribution columns to several classes of castings.

and in addition there will be the machine shop's proportion of the administrative distribution burden.

As a general rule I would suggest that the wood-pattern shop be kept a separate department, and capable of carrying its own burden. I believe in some plants it has been the custom to join this with the machine shop; but I venture to think that it is the wiser plan to have them separated. It is a shop by itself—that is, its work has but very little bearing upon any of our other shops, its principal work being of course the making of new wood patterns and repairs to wooden flasks, etc. A form similar to the machine-shop burden form can be used for this.

We have now to consider our General Burden Report, and as its name implies this is a report in which those charges are recorded that belong to no particular shop, but are a burden on the whole plant *pro rata*. And the first item of this nature is our power and water. We will assume we generate our own power. In order, then, to arrive at the cost of this, it will be necessary for us to keep track of the coal used in our boilers, and the cost of this should be charged through our stores ledger. It will also be essential that our electrician furnish us with the correct percentages of power used in each of the various shops, not only for lighting, but for elevators, cupola blowers, etc. In addition to this we must see that the wages of our electrician, engineer, fireman, and any of their assistants are correctly distributed. With this information, then, we can obtain the total cost of our power, and apportion it to the various shops according to the figures given us by the electrician.

The next item we will call General Shop Expense, and this consists of those many little incidentals which crop up, and which it is impossible to charge to any particular shop. Under such a category as this we might put our watchmen.

A third item in connection with this report will be our warehouse expenses, whilst another will be our clerical help; and finally there would be our rent, rates, taxes, depreciation, etc., and in fact all those factors which go to make up our office expenses. As soon as all this information has been detailed, we shall then have to pro rate the total over the several shops. It will then be necessary only for us to make a summary of each of our reports from which we shall be able to arrive at an accurate cost of our saleable product for each class of castings.

Obviously this is only a brief outline of the method by which all our costs are concentrated, but I trust it will be sufficiently explicit to give a clear outline of what is required in the accurate determination of costs. As I have previously stated, elaboration can very easily follow. The main point is to have a cost system, and a real live one at that. Let what you undertake be thorough, otherwise your results will not be of much account. One writer has well said that "all our accounting arrangements no matter how elaborate, or how carefully planned, can only *show* results, not *produce* them." At the same time it must not be thought that the cost system is a secondary consideration, but productions and costs should go hand in hand, as it is only by such co-operation we are able to point to defects and use the best means at our disposal to remedy them.

In conclusion I would urge the necessity for the speedy compiling of costs each month, as very often if any length of time has been allowed to lapse before calling attention to weaknesses shown up in our reports, the opportunity of remedying such evils has slipped by.

THE HEATING, VENTILATING AND AIR-CONDITIONING OF FACTORIES.

By Percival Robert Moses.

II. THE REGULATION OF HUMIDITY, AIR WASHING, AND COSTS.

IN many processes of manufacture, the regulation of humidity is of more importance than the heating of the building or the ventilation of the building.

In spinning or weaving mills, the question of heating is of comparatively little importance, because the operation of the machinery generates more heat than is necessary to take care of the building losses. The presence of too dry air, however, induces the development of static electricity, because it is a poor conductor, reduces the tensile strength of the fibre produced, and decreases the value of the product. The same is true in silk manufacture, and it is almost impossible to secure an evenness in texture without the regulation of the moisture in the air. In some processes, dry air is required, such as in steel manufacture, where the removal of moisture from the plant results in a great economy in the production of the steel and a marked improvement in the quality of the product, particularly as to its uniformity.

The subject of the humidifying of air is of extreme interest and it is absolutely bound up with the control of the temperature. It may be well to say a few words regarding the general subject of humidity. For every temperature of air there is a corresponding quantity of moisture which will be carried in each cubic foot without precipitation. The quantity carried increases with the temperature, as follows:

GRAINS OF MOISTURE PER CUBIC FOOT IN SATURATED AIR.

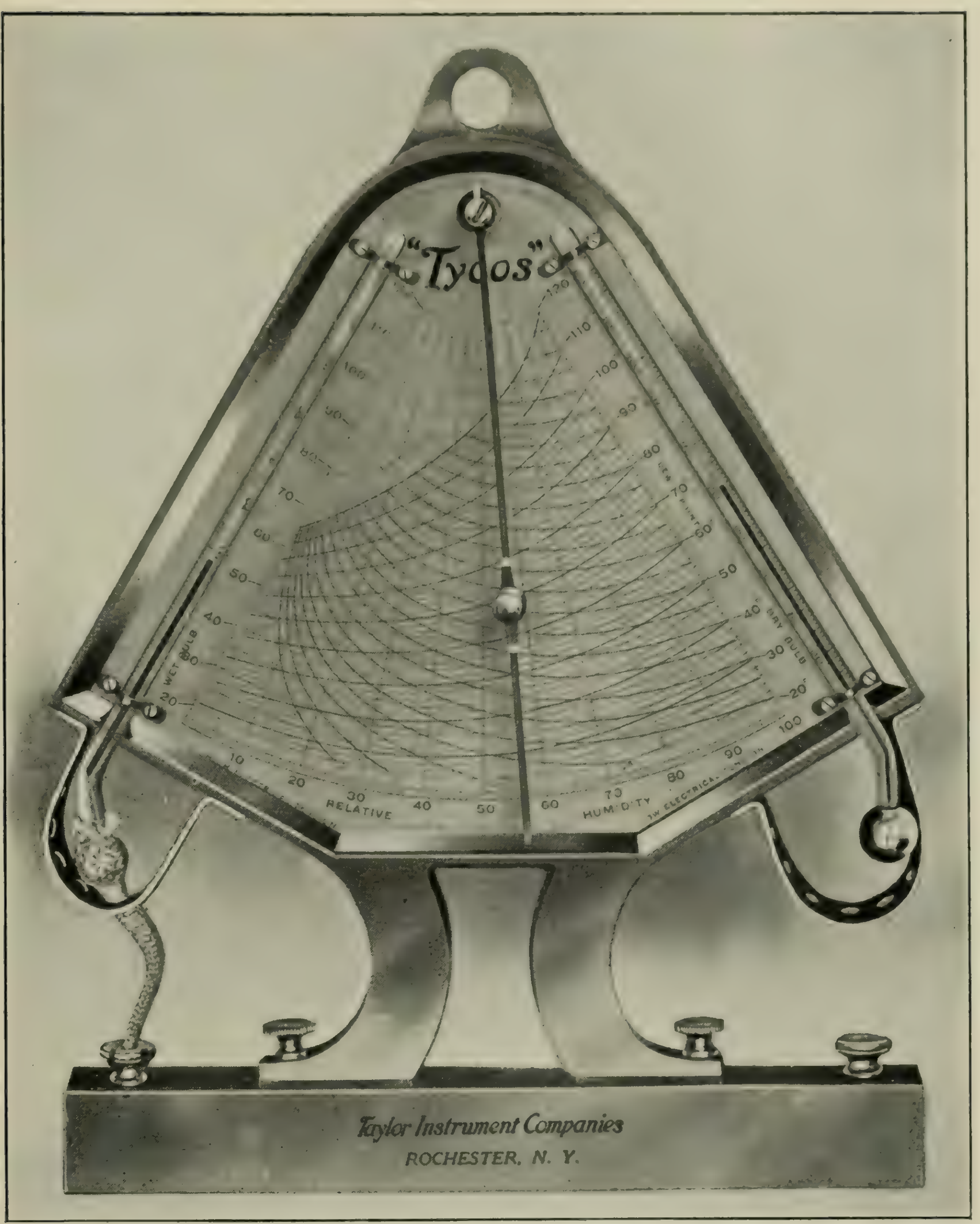
Dry Bulb Temp.	Grains.	Dry Bulb Temp.	Grains.
0 F.	0.48	65 F.	6.78
10 "	0.78	70 "	7.98
20 "	1.24	75 "	9.36
30 "	1.94	80 "	10.93
40 "	2.85	85 "	12.74
50 "	4.08	90 "	14.79
60 "	5.75	120 "	34.80

At 120 degrees F. a cubic foot of air will carry 34.8 grains of moisture. If, therefore, air at 120 degrees were introduced into a room in a saturated condition and were allowed to cool to 70 degrees, nearly 27 grains of moisture would be deposited for every cubic foot of air thus introduced, or one pound for every 260 cubic feet; and, *vice versa,* if air at 70 degrees were introduced into a room and allowed to heat to 120 degrees, instead of being in a saturated condition, as it was at 70 degrees, it would have less than one-quarter the quantity of moisture it is capable of carrying.

The relation between the quantity of moisture actually contained in the air at any given temperature and the quantity of moisture carried at the saturation point for that temperature is called the "relative humidity." This relative humidity is indicated by the difference between the temperature shown by a wet-bulb thermometer and a dry-bulb thermometer, or as shown by the hygrodeik.

Tables showing the ratio of wet-bulb temperature to dry-bulb temperature, known as psychrometric tables, show that for any given percentage of humidity within a temperature range of 20 degrees F. the ratio of the wet-bulb temperature rise to the dry-bulb temperature rise is practically constant. This approximate uniformity of difference for a stated degree of humidity is taken advantage of in one system of regulation to permit the regulation of the humidity and its maintenance at any desired amount. With this system, it is desired, for example, to maintain a humidity of approximately 70 degrees. A humidity of 70 degrees is equivalent to a difference between the wet and dry bulb of from 5 to 7 degrees. Hence, if by some means, the temperature in the room to be humidified can be kept at from 5 to 7 degrees above the temperature of the saturated air delivered from the humidifier, the resulting saturation in the room will be 70 degrees. The means adopted for maintaining the difference between the temperature of the air in the room and the temperature of the air issuing from the humidifier is to open and close the damper admitting the supply of heated air in winter or cool air in summer, and thus by regulating the quantity of saturated air delivered regulate the temperature of the room.

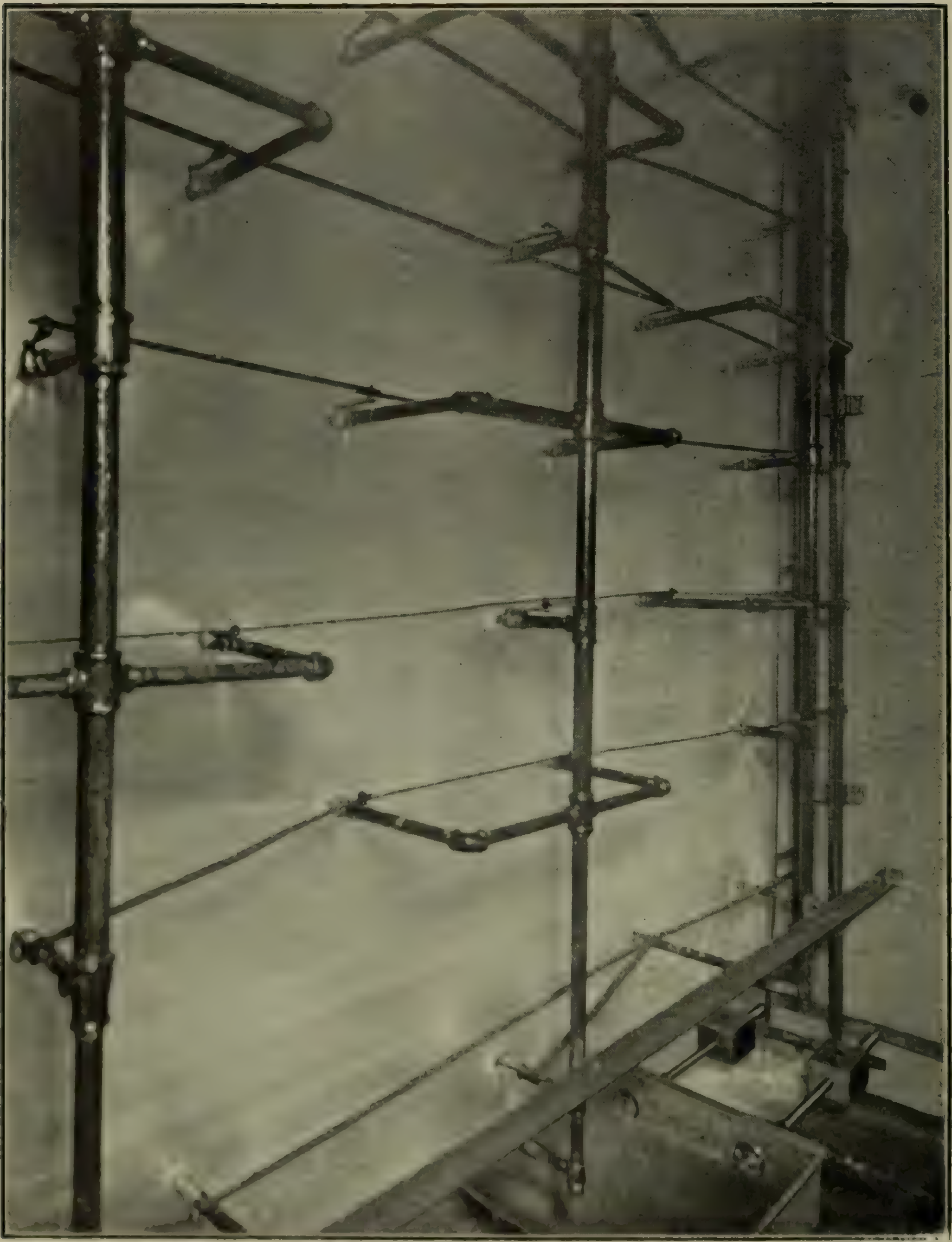
The necessity for a constant difference in temperature also introduces the requirement that in winter, when the temperature of the room must be maintained at about 70 degrees as a minimum, the temperature of the air when it is being saturated must be between 64 and 65 degrees. In order to obtain this temperature, it is necessary to heat the air. This is done in this system by allowing steam to mix with the water in the humidifying chamber. The steam is automatically



THE HYGRODEIK, FOR MEASURING THE RELATIVE HUMIDITY OF THE AIR.

shut off as soon as this water reaches the desired point, 64 or 65 degrees; as soon as it falls below the desired point, the steam supply automatically opens up.

Another condition demanding attention arises from the fact that in winter when the temperature of the room rises, as it does in the operation of machinery, and the temperature of the saturated air remains approximately at 64 or 65 degrees, it is necessary to decrease the amount of heated air supplied for ventilation and heating, while in summer time, when the supply is cooler than the air in the room,

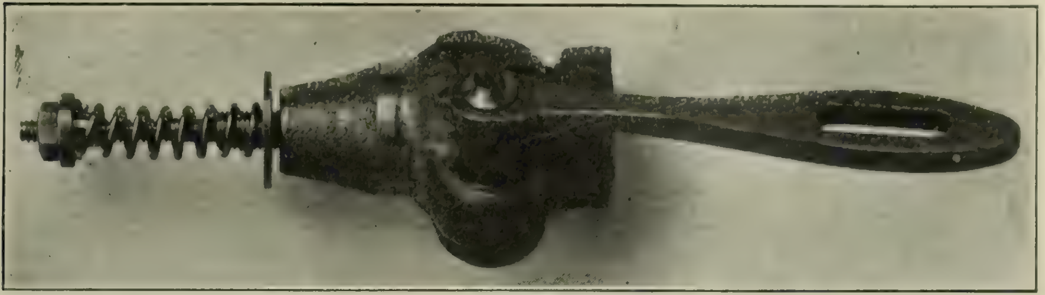


THE KINEALY AIR HUMIDIFIER, SHOWING SPRAY HEADS IN ACTION AND AUTOMATIC CLEANING DEVICE.

Kauffman Heating and Engineering Co.

it is necessary to increase the quantity of air supplied in order to decrease the room temperature and maintain the required difference in temperature. It becomes necessary, therefore, for the automatic thermostats which close the dampers to operate in one direction when the temperature of the air delivered to the room by the duct system is higher than the temperature of the air in the room, and in the other direction when the temperature of the air is lower. This operation is carried on by what is known as the differential thermostat.

Another method is to use an intermittent system of humidifying, the spray being turned on and off as the relative humidity rises and falls. There are other systems of localized hanging humidifiers with and without fans, but these do not control the temperature, hence do not accomplish fully the result considered in this article.

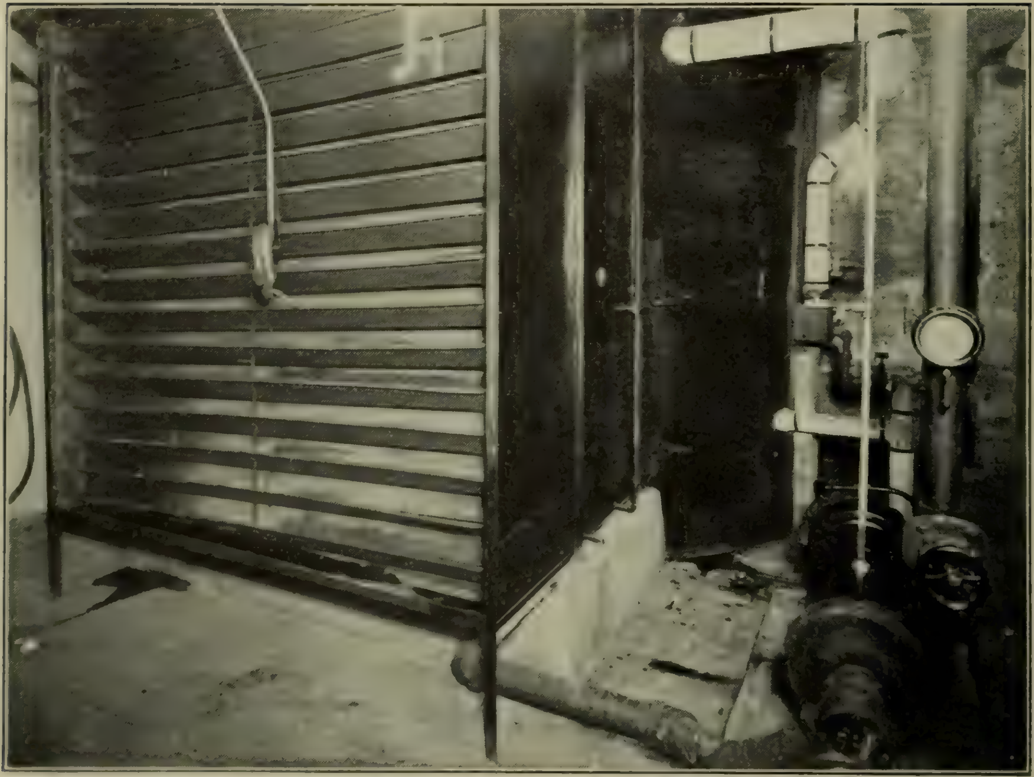


LATEST TYPE OF KINEALY SPRAY HEAD FOR AIR HUMIDIFYING.

The regulation of humidity has also a commercial value in addition to the value arising from betterment of product and more uniform quality. Wherever textile yarns or similar material is sold by weight, the percentage of moisture has an important bearing on the results. Standards have been fixed as to the allowable amount of moisture, this amount being determined by the difference in weight between a sample dried in an oven and a sample as delivered. If a manufacturer delivers yarns or other material with less than the allowable percentage of moisture, he loses a legitimate amount of profit. This percentage of moisture is known as the "regain." The usual allowance varies from 8½ per cent with cotton to 17 to 18¼ per cent with wool. If the relative humidity in the mill is maintained at approximately 70 per cent with 70 degrees temperature, 73 per cent with 80 degrees temperature, 76 per cent with 90 degrees temperature, it is found that the amount of regain is about that allowed. If the humidity falls much below this, the amount of regain will be correspondingly reduced and the manufacturer suffers a loss, besides a loss in the value and strength of the product.

A series of tests made by Mr. J. H. M. Beaty, of Clemson College, South Carolina, showed that with 25 s yarns a reduction from 84 per cent relative humidity reduced the strength of the yarn 11.4 pounds; with 30 s yarns, a reduction from 95 per cent to 46 per cent reduced the strength of the yarn 19.2 pounds. It was also found that the percentage of broken ends is less with the higher percentage.

In hot summer weather, it is possible to cool down the incoming air from the temperature outdoors to the wet-bulb temperature, usu-



ELIMINATOR SIDES, KINEALY HUMIDIFYING INSTALLATION.

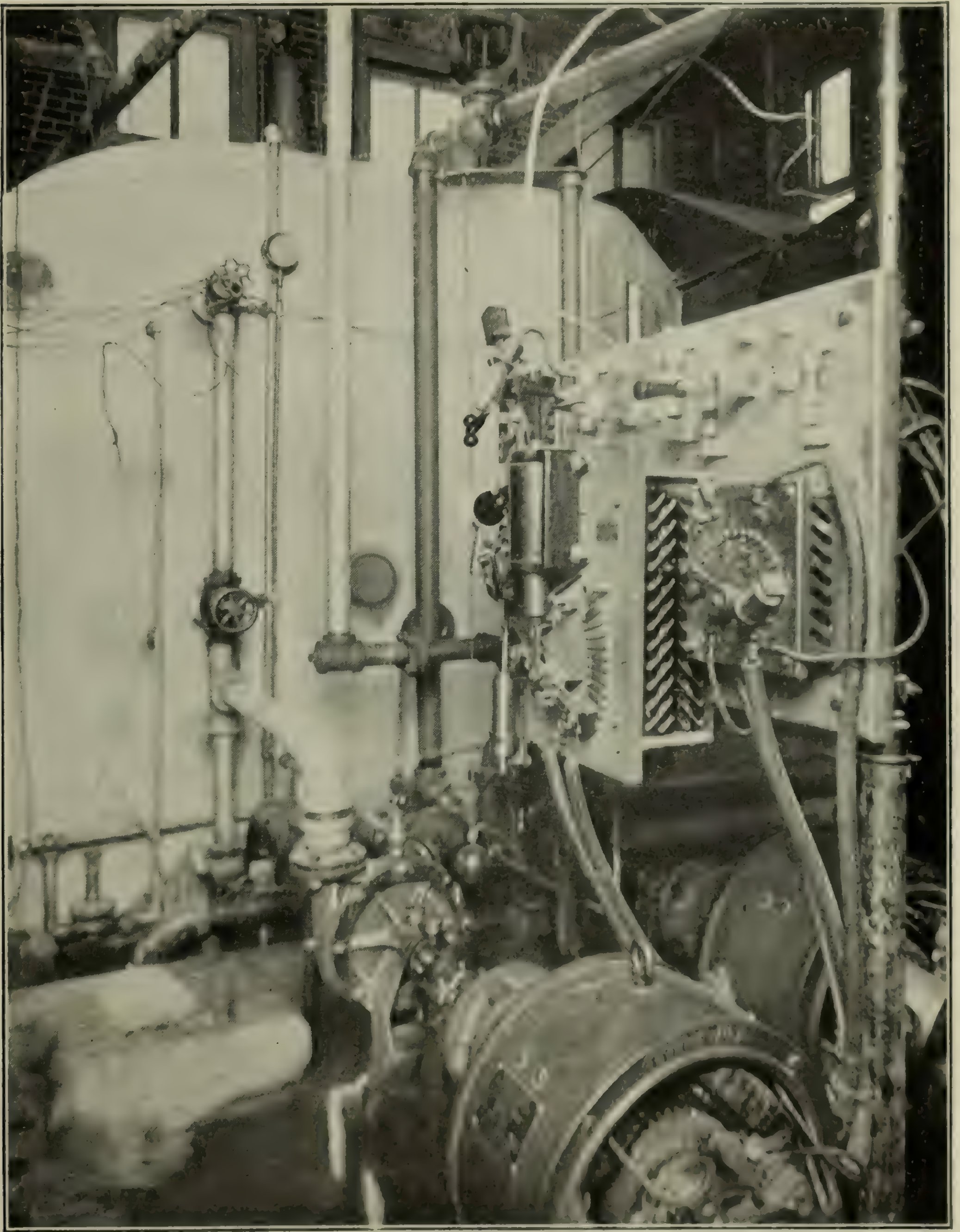
ally 10 to 14 degrees below the dry-bulb temperature outdoors. This air delivered to the mill is heated up by the heat from the machinery and a sufficient volume of incoming air is delivered from the humidifier to keep the temperature down to the difference required for maintaining the required amount of humidity. As it will be found that the amount of air required for this purpose is far in excess of the amount of air required for ventilation in winter, the ducts must be proportioned for summer work.

The extent to which these systems are carried may be inferred from the size of plant recently ordered for a large New England mill, where 412,000 cubic feet of air per minute are to be delivered. This mill is 360 feet by 133 feet, six stories.

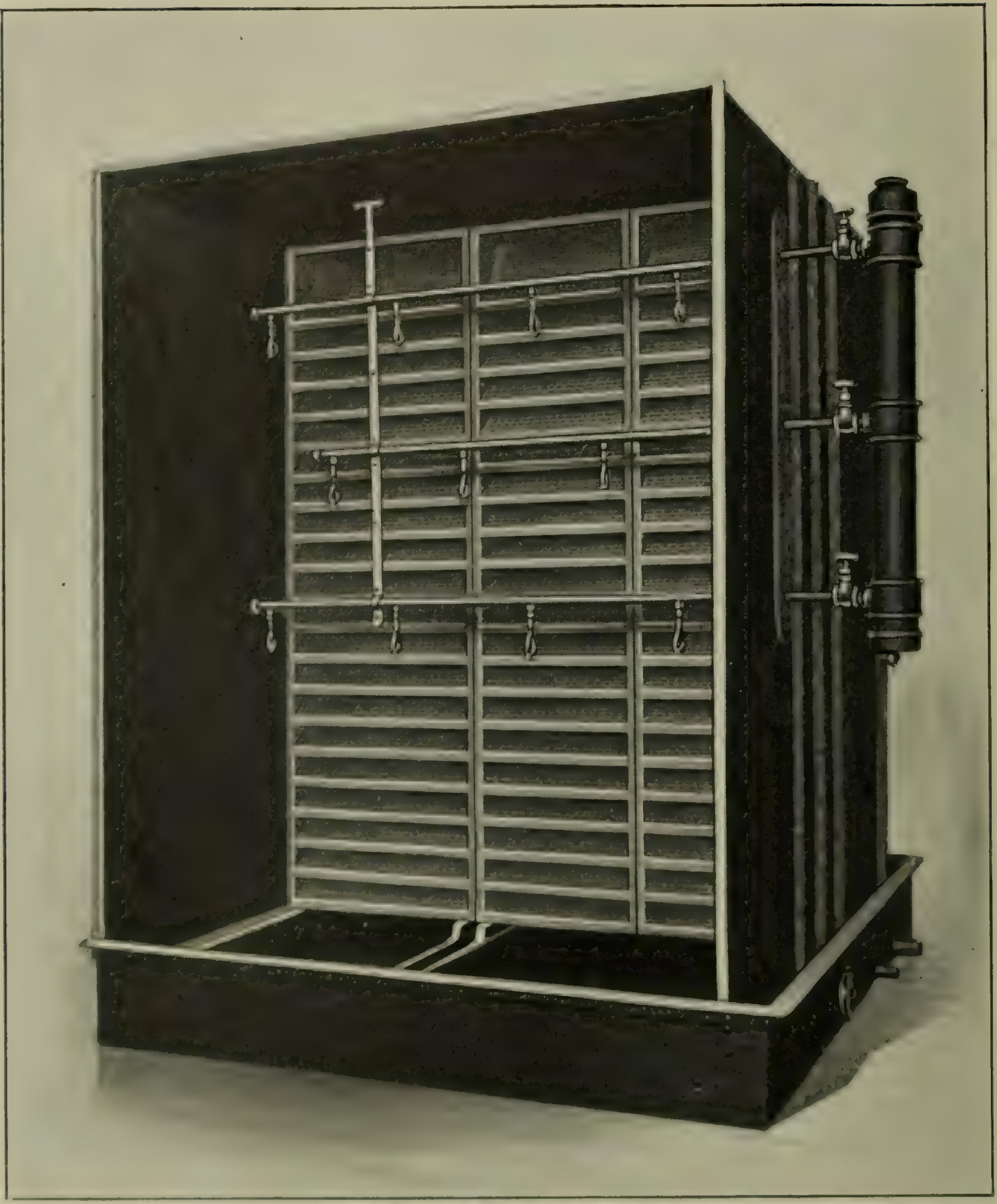
One fact frequently overlooked in the design of plants for such mills is, that the power delivered to the machinery—i. e., to the looms, knitting frames, etc.—is almost wholly transformed into heat, and it is for this reason that where a large amount of machinery is operated no extra heat is required, except for the early morning hours before the apparatus starts. In one of these large mills, 500 to 1,000 horse power may be used on a floor, and it is quite evident from a brief consideration of the mechanical equivalent of heat that no additional heat will be needed.

AIR WASHING.

Even when regulation of humidity is unimportant, air washing is advisable, as bacteria collect on the dust particles and air washing removes the dust and the bacteria with it. It is important in providing for air washing that the air leaving the air washer be kept down to such a point that when delivered into the room there will be no



REINFORCED-CONCRETE AIR-WASHING PLANT, MENGEL BOX FACTORY, LOUISVILLE, KY. McCreery Engineering Co., Detroit. The casings from air intake to washer and from washer to fans are all of cement plaster on metal lath.



THE PEERLESS AIR WASHER.
New York Blower Co., Chicago, Ill.

tendency for the deposit of moisture. It is usual to keep the temperature of the saturated air on leaving the air washer or humidifier at 20 degrees below the temperature of the air in the room. By this means, even if saturated air is delivered to the room, it will rise in temperature when mixed with the air of the room, and as its capacity for moisture increases with its temperature there will be no tendency to deposit the moisture.

As the air is usually delivered through long galvanized-iron ducts, which carry sound, the question of noise from the air washer is of importance, and for this reason the "mist" type of air washer is probably preferable to the "spray" or "rain-water" type. The use of baffle-plate eliminators to take out the entrained moisture also serves to reduce the noise; and a further precaution is to install between the air washer and the fan a flexible canvas connection. The question of noise is not, of course, of great importance in factory work.

Heating.

The question of heating the building is intimately connected with the question of the air supply, as every cubic foot of air brought in from outdoors must be heated up to at least the temperature of the room which it is to enter.

In considering this question of air supply, two distinct factors must always be considered:

1. The amount of air required for ventilation.

2. The amount of heat to be added to warm this air, and also to provide for the losses through walls, windows, skylights, doors, etc., or the amount of heat to be abstracted to cool it.

It is evident that if a factory is used for storage purposes on two or three floors, no ventilation is required but a certain amount of heating or cooling is necessary, depending upon the contents. On the other hand, if the floor is full of operatives, or if machinery is being operated, the amount of heat required is reduced, but the amount of air required for ventilation is increased and usually becomes of paramount importance. This, however, is not the case during the night time, unless the shop operates the whole twenty-four hours, full-shift, nor is it the case during slack time, when perhaps half or two-thirds of the operatives are laid off, nor in the early morning hours when the building is being warmed up before work starts. At such times, the ventilation factor practically disappears and the sole question is one of heating. It follows from these considerations that a system designed for one particular state of affairs will be uneconomical under all the other conditions, unless provision is made for meeting the varying conditions as they arise.

If no provision is made for taking care of this "off-time" heating, except drawing air from outdoors and heating it up to the required amount to make good the losses, it is evident that for every 1,000 cubic feet of air brought in and raised to say 110 degrees, 2,000 heat units will be required, approximately equal to the condensation of 2 pounds of steam, while if this air is brought in at 70 degrees or 60 degrees only one-half the number of heat units will be required. This means that either the air must be re-circulated or provision must be made for heating the building, taking care of radiation losses through walls, windows, etc., by direct radiation surface, letting the ventilating fans supply only the air required for ventilation, this air being heated to merely the temperature of the room.

Provision for re-circulation, while a matter of economy in operation, is a doubtful expedient, except in certain instances; because as soon as the engineer in charge or the owner finds that by re-circulating the air more or less he can reduce the expense for fuel, he will adopt this method, and poor ventilation will result. The exceptions noted are such plants as have an excess of exhaust steam available, as in this case there is no tendency on the part of the engineer or owner to reduce the ventilation because no benefit would be obtained thereby. Another case is where re-circulation can be adopted continuously—i. e., where air can be withdrawn from storage rooms or storage floors, halls, etc., passed over heating coils, and distributed to the manufacturing departments.

Where re-circulation is not advisable, direct radiation must be resorted to if economy in steam is to be obtained. Direct radiation has also the advantage of supplying the required heat when natural ventilation is used and mechanical ventilation stopped.

In a climate such as that of New York, there are, perhaps, eight months in the year when windows can safely be opened and natural ventilation obtained, provided some means is given for warming the air coming in through the windows. During October and November, and even in December, and in March, April, and May, there are many days when natural ventilation is preferable to air received through ducts and flues after being heated. The air comes in with a "live" quality through the windows, varying in velocity, and it is to be preferred, and it will be preferred, to the air received from the fan system unless the manufacturing processes require a stated humidity.

During such times, it is highly advisable that the mechanical ventilating plant be shut down and the necessary heat obtained from coils and radiators around the room. At such times, mechanical ventilation is of no use, because even if mechanical ventilation is supplying the air as it is designed to do, open windows and breezes will entirely change the distribution of this air and prevent the proper distribution of the heat.

In ordinary workshops and factories, therefore, where there are no gases, dust or vapors to be removed, it is my practice to use a combination of direct and indirect systems.

COST OF VENTILATION.

Definite figures are always a better means of focusing the attention than are abstract discussions. Assuming that coal costs $3 a ton of 2,000 pounds and that there are 7,000 available heat units in each pound of coal (by this I mean that out of the 11,000 or 12,000 heat units available in a pound of No. 1 buckwheat coal, between 7,000 and 8,000 are actually delivered into the room in the form of heat in the air, the remainder being lost through radiation in connection with the boiler setting, ducts, fans, and heaters or allowed to go to waste without doing any good), and assuming extreme conditions of zero degrees weather outdoors and an indoor temperature of 65 degrees, the cost of heating 1,000 cubic feet of air from zero degrees to the temperature of the room, when exhaust steam is not available from the steam engine, is as follows:

$$1{,}000 \times \frac{13}{55} \times 300 \text{ cents} \div 2{,}000 \text{ pounds} \div 7{,}000 \text{ heat units.}$$

The result is 1/40 cent; this is the cost of heating 1,000 cubic feet of air from zero degrees F. to 65 degrees F. This may be taken as the maximum cost of ventilation.

If the air is to be heated from zero degrees to 130 degrees, or from 10 degrees to 140 degrees, the cost is 1/20 cent. If we assume the average winter temperature to be about 32.5 degrees F., it is evident that the saving to be obtained by re-circulation of the air would be 1/80 cent per 1,000 cubic feet of air delivered—i. e., if it cost 1/40 cent to heat the air from zero degrees to 65 degrees, it would cost 1/80 cent to heat it from 32.5 degrees to 65 degrees F. Again, if 1,000 cubic feet of air will act as a carrier for 65,000 ÷ 55 B.t.u. if the air is allowed to drop from 130 degrees to 65 degrees F., or from 140 degrees to 75 degrees F., this is equivalent to 1,182 B.t.u. 1,182 B.t.u. is about the amount of radiation obtainable from 4 square feet of radiation an hour with exhaust steam at from 1 pound to 5 pounds pressure; it follows from this that for 4 square feet of direct radiation, a saving of 1/80 cent per hour is made over the cost of heating directly by a fan system drawing the air from outdoors—always provided that there is not sufficient exhaust steam to heat the coils of the fan system; and every square foot of radiating surface saves 1/320 cent per hour.

It is also true that every 1,000 cubic feet of air re-circulated, instead of being taken directly from outdoors, saves 1/80 cent.

Assume a building requiring 1,800,000 B.t.u. per hour, to make up the losses through walls, windows and other openings. This amount of heat could be either supplied by 6,000 square feet of coil radiation along the walls, or it could be supplied by a fan system taking the air from outdoors, heating it to 140 degrees and allowing it to fall to 75 degrees. The saving in such a building, allowing for starting up two hours earlier in the morning—about 5 o'clock if the building opens at 7 o'clock and stops at 6 o'clock at night—making 13 hours of operation, would be 18 cents per hour, and the average saving per day would be $2.34. The same saving, approximately, would be made if all the air supplied, except that required for ventilation, were obtained by re-circulation.

In the case just assumed, with a maximum requirement of 1,800,000 heat units an hour, it would apparently be necessary to deliver approximately 1,500,000 cubic feet of air per hour at 140 degrees F., or 25,000 cubic feet of air per minute. A building requiring this amount of heat would be a building about 125 feet square, of five to seven stories, with the usual amount of glass and exposure. Such a building, however, might house from 200 to 300 employees or there might be only 100.

Allowing for a maximum of 300 employees, the total amount of air required per hour for ventilating purposes would be 600,000 cubic feet. This air could also be used for supplying heat and no extra loss would be involved. 600,000 cubic feet of air falling from 140 to 75 degrees would give out approximately 720,000 B.t.u. per hour. This would leave about 1,000,000 B.t.u. to be provided for by re-circulation, less 150,000 B.t.u. from the operatives and 100,000 from say 40 horse power of machinery; the amount of air to be re-circulated would be finally between 10,000 and 11,000 cubic feet per minute, and this only in severe weather.

In this connection, the following figures may be of interest, as they afford a rough means of figuring the amount of direct radiating surface required. Taking the usual conditions around New York as a basis, a requirement of 10 degrees F. as the outside temperature, and 65 degrees F. inside, with walls 12 to 16 inches thick, the number of heat units required per hour would be:

The amount of glass surface multiplied by 70 plus the amount of wall surface multiplied by 18; number of operatives multiplied by 1,500 less the number of horse power of machinery multiplied by 2,500. If no air is supplied for ventilation, allowance must be made for infiltration of air, and it is usual to figure that the air will be changed in one hour. In such case, add one heat unit per 1,000 cubic feet of contents of building to be heated. These figures result in the following formula for direct radiation:

$$\text{Sq. ft. radiating surface} = \left(K \left(\frac{G}{4} + \frac{W}{16} + \frac{\text{M Cu. Ft.}}{300} \right) \right) - \left(\frac{5\ \text{oper}}{3} + 9\ \text{HP.} \right)$$

K is a variable quantity, varying from one to one and one-fifth, depending upon exposure—continuous or partial, time heating, etc.

These figures are based on a radiation of between 280 and 300 B.t.u. per square foot per hour from coil heating surface, placed alongside the outside walls under the windows, with the conditions of temperature noted.

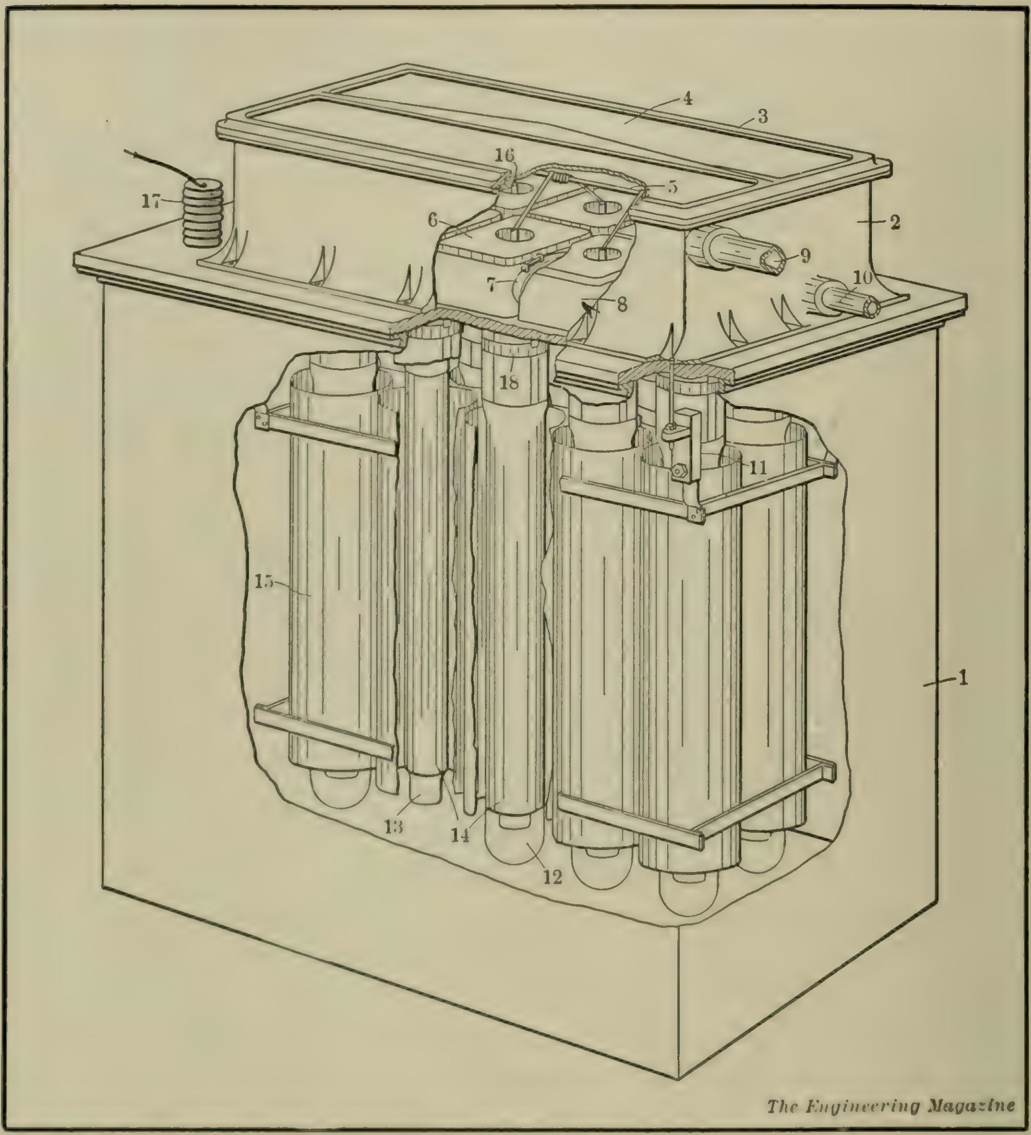
The amount of surface required for heating air supplied by the fan system is an entirely different quantity from that required for direct radiation, as the amount of condensation in a pipe or coil increases as the speed at which the air is discharged through the coils increases; because the heat is transferred from the coils to the air largely by convection—very little by radiation.

While it is true that the total rise in temperature will be greater with a greater depth of heater, it is also evident that after the air has passed over the first few rows of coils it approaches more nearly the temperature of the steam in the coils, and hence the rate of transmission is very much less and the added surface is nothing like of proportionate value. This is one reason why it does not pay to run the temperature of the air, for heating purposes, up above 135 or 140 degrees, as in order to obtain a higher temperature it becomes necessary to make the heater very much deeper and the cost of installation increases at a greater proportion than the results warrant.

If the steam in the coils is at a temperature of 220 degrees and the incoming air is taken at an average of 30 degrees, there is a difference of 190 degrees between the surface of the first sections and the incoming air, while at the end of the heater, where the air leaves, there is a difference only of between 70 and 80 degrees—i. e., between 220 and 140 or 150 degrees. Hence, the amount of heat transmitted in the first sections of the heater should average twice the transmission in the latter end.

A matter of importance in connection with any ventilating system is the character of the air delivered into the system. Out in the country, in a factory plant, where the air is clean and not befouled with smoke or other fumes, the air supply for the ventilating system may be taken wherever it can most conveniently be obtained; but where this is not the case, where the work-shop or factory is located in the city, or where the processes involved befoul the air around the factory, there are several points to be considered.

The first is the location of the intake in the cleanest possible position; and if it is not possible to obtain clean, fresh air by the location of the intake, then it becomes necessary to provide some means for the cleaning of the air. The delivery of dirty air is not only bad from



The Engineering Magazine

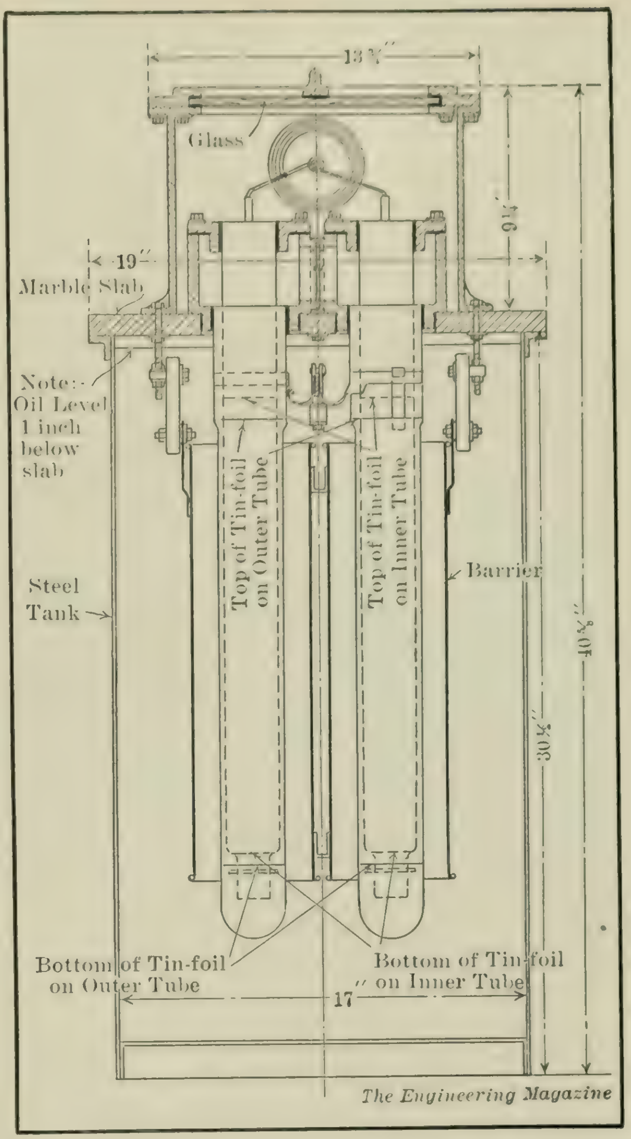
PERSPECTIVE VIEW OF GERARD TEN-TUBE OZONATOR.

1, steel tank; 2, aluminium casing; 3, casing cover; 4, glass; 5, upper bus bar; 6, inner tube holder; 7, tightening band; 8, outer tube holder; 9, dry-air inlet; 10, ozone outlet; 11, barrier insulator; 12, outer tube; 13, inner tube; 14, tinfoil; 15, barrier; 16, glass holder; 17, insulator; 18, outer tube contact.

a sanitary point of view, but in a great many processes of manufacture the delivery of dusty air causes a marked deterioration in the quality of the product, and in fact the result may be so injurious as to make the operation of the ventilating system impossible.

The location of the intake has a bearing on the economy of operation. If the air supply is to be used for heating, or if it is to be used mainly in cold weather, it is advisable to locate the air supply on the warm side of the building. On the other hand, if the ventilating supply is intended to cool the room, as an engine room, the intake should be located on the cool side of the building—i.e., in this climate, on the north or east side; the warm side being the south or west.

The size of intake will also have a bearing on the freedom of the air from dust. If the size is restricted so that the velocity is excessive—i. e., above 800 feet per minute—there is a greater tendency for the drawing in of dust than there is if the velocity is kept low—say, 500 feet per minute. The method of cleaning the air has been discussed, but whatever method is adopted, provision must be made for the screening and removal of the dirt taken out of the air, otherwise the so-called cleaning apparatus becomes a menace to health and detriment to the operation of the ventilating plant.


13⅜″
Glass
9¼″
19″
Marble Slab
Note:- Oil Level 1 inch below slab
Top of Tin-foil on Outer Tube
Top of Tin-foil on Inner Tube
Barrier
Steel Tank
40⅝″
30⅝″
Bottom of Tin-foil on Outer Tube
Bottom of Tin-foil on Inner Tube
17″

The Engineering Magazine

CROSS SECTION OF GERARD OZONIZER SHOWING ASSEMBLY OF PARTS.

Insofar as the exhaust outlet is concerned, the main points to be observed are that the outlet should be placed away from the inlet and away from windows, and it should also be provided with a hood so designed that wind pressure will facilitate the exit of the air rather than retard it.

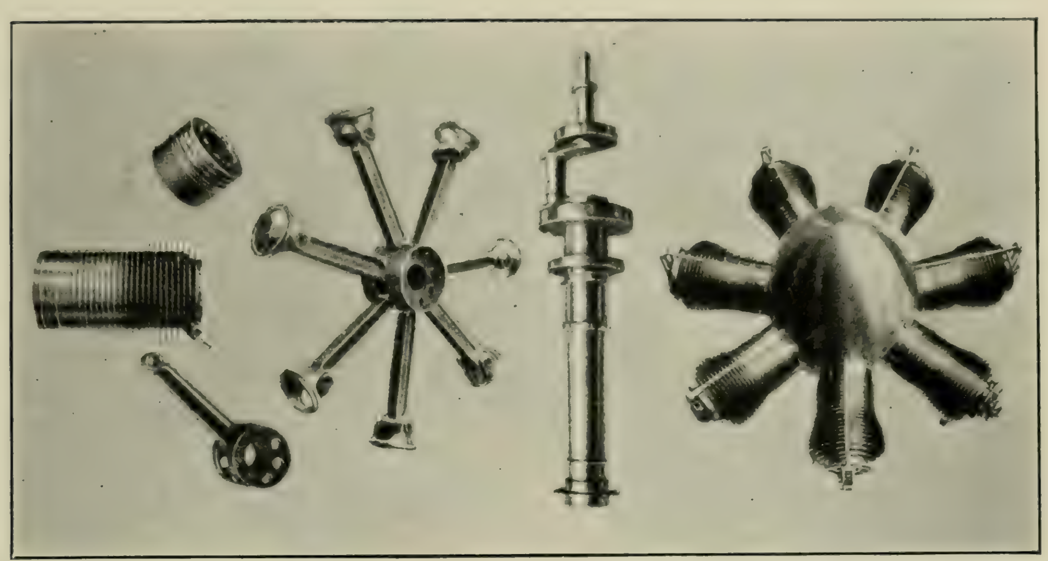
A discussion of the heating and ventilating of factory buildings would not be complete without some reference to the subject of ozonization. Practice is still in process of development, and although the use of ozone as a purifying agent has become more or less general in Europe it has only been tried experimentally in the United States and with no very definite results. The most notable

American instance is the installation in the Chicago Public Library Building, and while the offensive odor seems to have been removed from the air the authorities are not yet prepared to make a definite statement as to the advisability of installing a complete ozonizing apparatus.

A letter from the Hoftheater, Stuttgart, herewith presented in translation, speaks very well for the results obtained in that installation, and it would seem to me probable that ozone could be employed to advantage in confined spaces where ventilation by the introduction of fresh air and the removal of foul air was not readily possible:

> (*Translation*)
>
> Replying to your letter of the 7th instant, we have honor to inform you as follows:—
>
> The ozone apparatus of the Elworthy-Koelle system installed by us in the year 1906 has proved very good in every way. The unfavorable conditions in the local Hoftheater did not formerly permit of successful ventilation of the auditorium during performances. Since the ozone apparatus has been in service there is no longer impure air in the auditorium, and the temperature is not unbearable even with the house full. Flying dust settles on the ground in consequence of the cool ozone, and the scenes on the stage stand out more clearly in consequence thereof.
>
> The apparatus which is connected to the electric circuit, and which consumes current to the amount of only 20 horse power per evening, permits of the distribution of the ozone (generated by electricity) to the remotest parts of the theatre.
>
> It is installed in the ventilating chamber; thence, the ozone passes through air ducts into the auditorium. Furthermore, a special tube system with two branches runs into the orchestra pit and to the supers' room.
>
> The air improved by the ozone has the normal amount of humidity. The effect of ozonization of the air is a double one: On the one hand, it stimulates the audience, which is made uncomfortable by unhealthful substances and germs exhaled by the crowd of people, and on the other, produces a favorable effect upon the vocal wellbeing of the singers and upon the physical condition of the orchestra.
>
> Very respectfully,
> (Signed) BARON PULLIN.

The process of ozonizing air is essentially the same in the different systems, and consists of forcing air through tubes through which an electric discharge takes place, the electric discharge changing the particles of O_2 to particles of O_3. This extra atom of oxygen is only temporarily attached, and at the earliest opportunity it will combine with any carbonaceous material, performing a chemical combination which amounts to the same thing as burning up the organic matter present in the air.

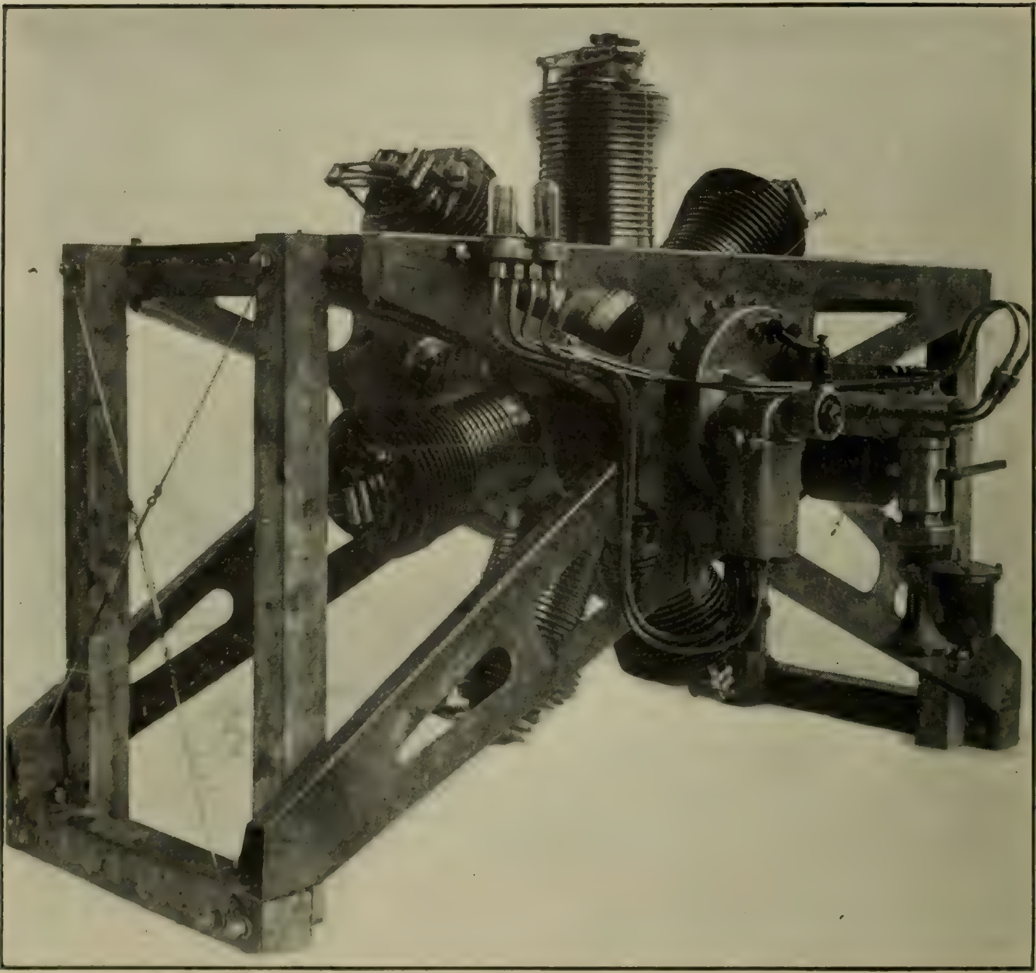


GNOME MOTOR; AVIATION HOOD AND INTERIOR PARTS.

FRENCH AEROPLANE MOTORS.

By Warren H. Miller.

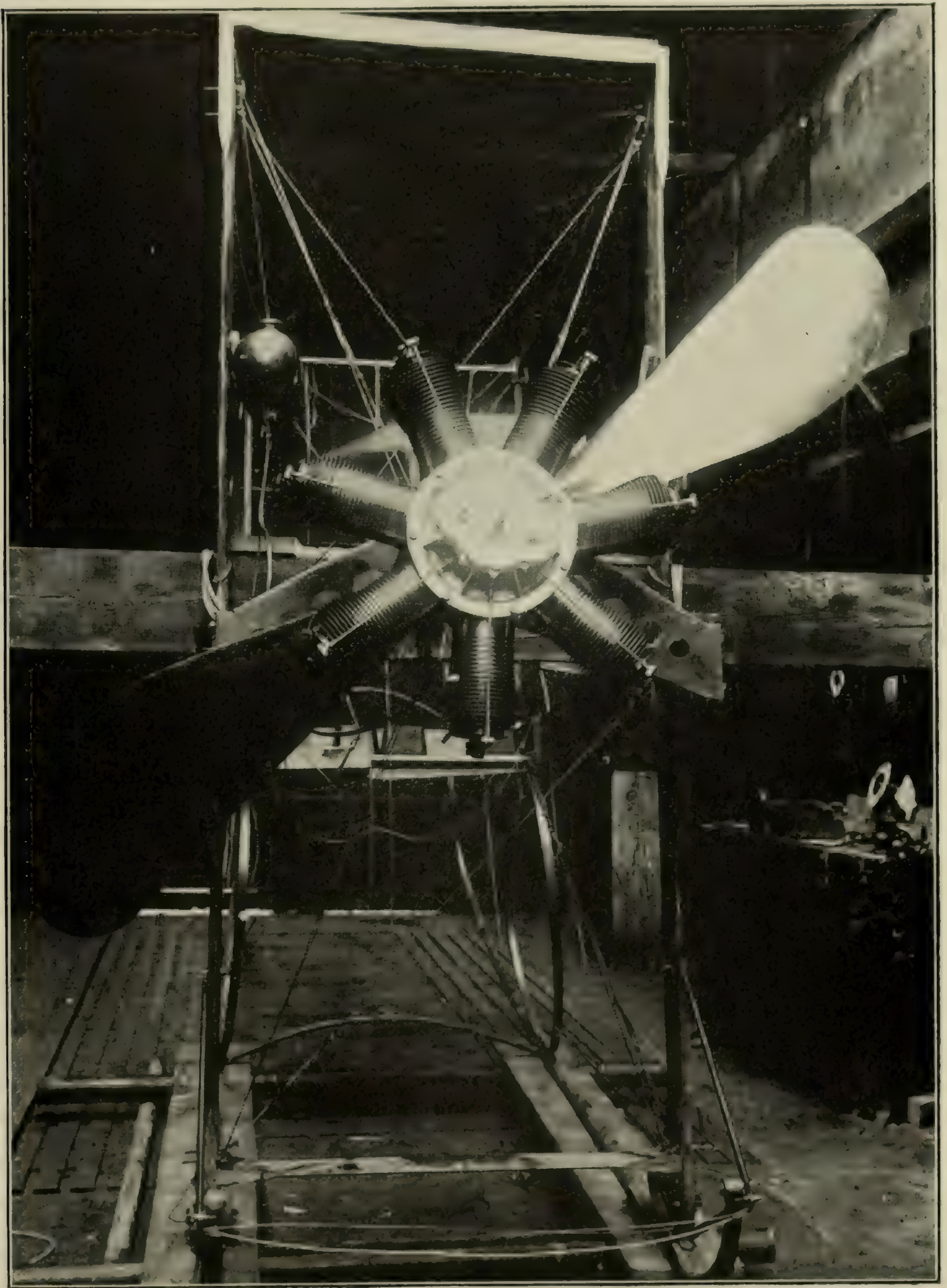
SO long as the weight of gasoline motors remained at about 20 pounds per horse power there was little hope of doing anything in the way of practical results with the development of aeroplanes. Even in the very smallest plane the presence of the element of skilful, trained *human* control is absolutely necessary; therefore the dead weight of the motor and aeroplane, plus the live weight of the pilot, would be the least that could be considered. For this reason the nicest and best calculated designs of the earlier men, who had to use steam for motive power, always failed. They either were so heavy that a man could not be carried besides the motor, or else they used up far more steam than any boiler could generate in the required time, so that the flight exhausted all the reserve steam in a few minutes. It was to the development of the automobile industry that the light motor that made aviation possible is due, running now as light as two pounds per horse power. That by the Société Gnôme is 3.36 pounds per horse power, is much used, and holds two of the



PRESSED-STEEL MOUNTING FOR GNOME MOTOR, FARMAN AND SOMMER BIPLANES.

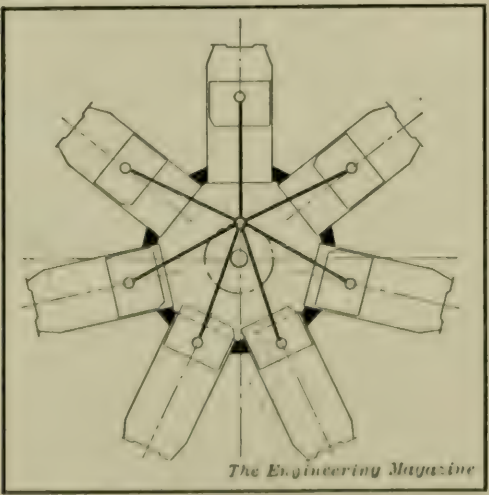
world's records—that by Paulhan at Los Angeles for height of 1,520 meters, and that by H. Farman of 232.2 kilometres in 4 hours 17 minutes 53 seconds for distance and duration, so it will be well to begin the list with it.

As will be seen by the cut, it has seven cylinders, which form the flywheel as they rotate about the crank, which is fixed. The one idea of this motor has been to obtain lightness by the design and not by the materials. There is no aluminium anywhere in it, nor any cast pieces. The cylinders are machined complete, vanes and all, out of solid blocks of forged steel, and all the reciprocating parts are of nickel-steel. The body is of tool steel, and the cylinders are secured to it by segmental rings locking in the annular rings cut on the cylinders, and held in place with keys. Thus any cylinder can be taken off instantly. The general working of the motor, which is four-cycle, is apparent at a glance at the line-section on page 884. Page 881 shows details of the crank, pistons, valves, and connecting rods. The master-bearing, to which all the connecting rods are attached, has two sets of ball-bearings on the crank, and the inlet valve seats form also the housing for the connecting-rod pins. The inlet valves are counter-weighted against the centrifugal force of the rotation by small lever



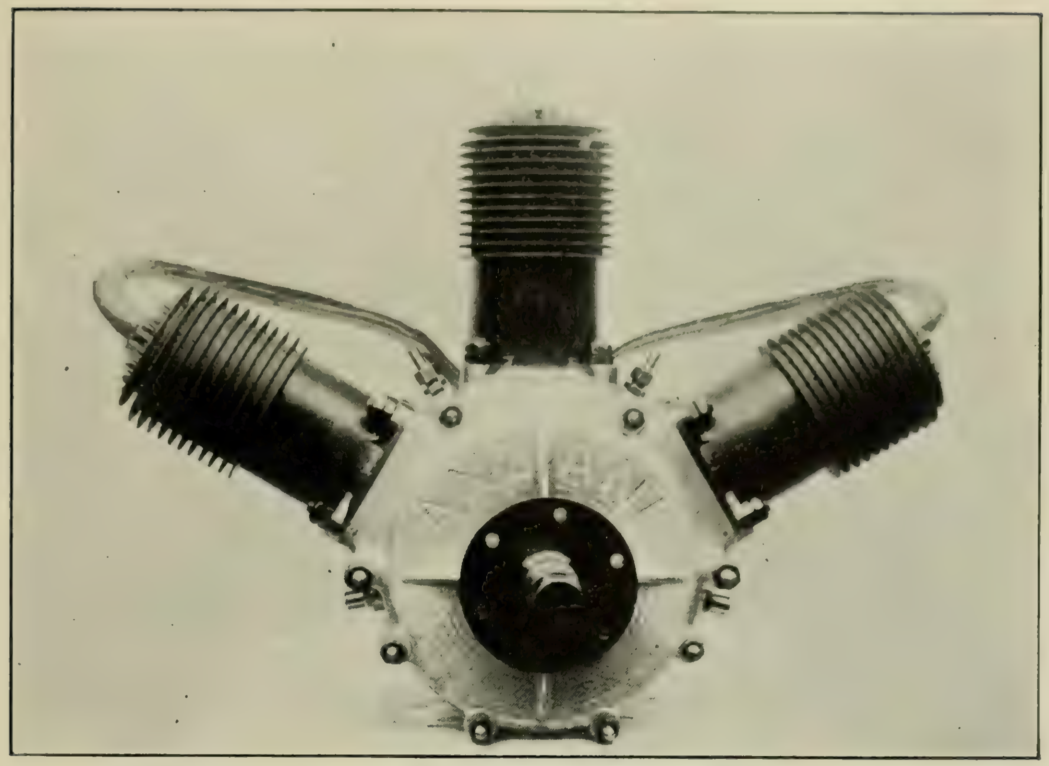
FACTORY TEST OF GNOME MOTOR ON THE CHASSIS OF A BIPLANE.

counterweights, so that they open properly for admission. The escape valves are in the tops of the cylinders, opening inwards by rolling cams, connected by their rods to the trip-movement in the main bearing case. The exhaust simply escapes into the air. Cooling is entirely by the vanes machined out of the cylinder forgings, which, of course, rotate at great velocity. The motor is attached directly to the propeller, and the flywheel effect of it has proved of great value in aviation, as many other motors, which depend on the screw and 90-degree cranks for uniform rotation, have had unaccountable breaks in the screw while under way, making it necessary to glide back to earth without power. The gasoline is mixed by a float-feed automatic air inlet carburettor, and fed into the crank case through the shaft, which is hollow, and the oil is pumped in by a rotary force pump through the same channel. Once inside, it is carried by the centrifugal force through ducts to every moving part of the cylinders. The spark-plugs project some distance into the interior of the cylinder, and are thus protected from the oil, which collects on the ends of the cylinders and passes out with the exhaust. Ignition is by magneto, with seven-point timer. This motor is made in three sizes, 30, 50 and 100 horse power, of 5, 7, and 14 cylinders respectively. The 30-horse, for light monoplanes, is 4 inches bore by 4 inches stroke, 1,300 revolutions per minute, 132 pounds weight. The 50 horse power is 4½ inches by 5 inches approximately, 1,200 revolutions per minute, 168 pounds weight. The 100 horse-power has the same bore and stroke, twice the number of cylinders, same revolutions, and weighs 220 pounds.



THE GNOME MOTOR. DIAGRAMMATIC SECTION.

The next motor to notice would undoubtedly be the Anzani, the one which flew across the Channel with Blériot in *Blériot XI*. This is made in four sizes, 15, 30, 40 and 50 horse power, all of three cylinders, arranged as on page 885. The cooling is by the circular vanes, cast integrally with the cylinders, in steel. Inside the case are two flywheel plates forming the faces of the crank, one of which is cammed, to act on the valve rods of the exhaust, thus cutting out the necessity of valve shaft and its gears. The admission valves are in the cylinder-heads, supplied by a three-branch pipe

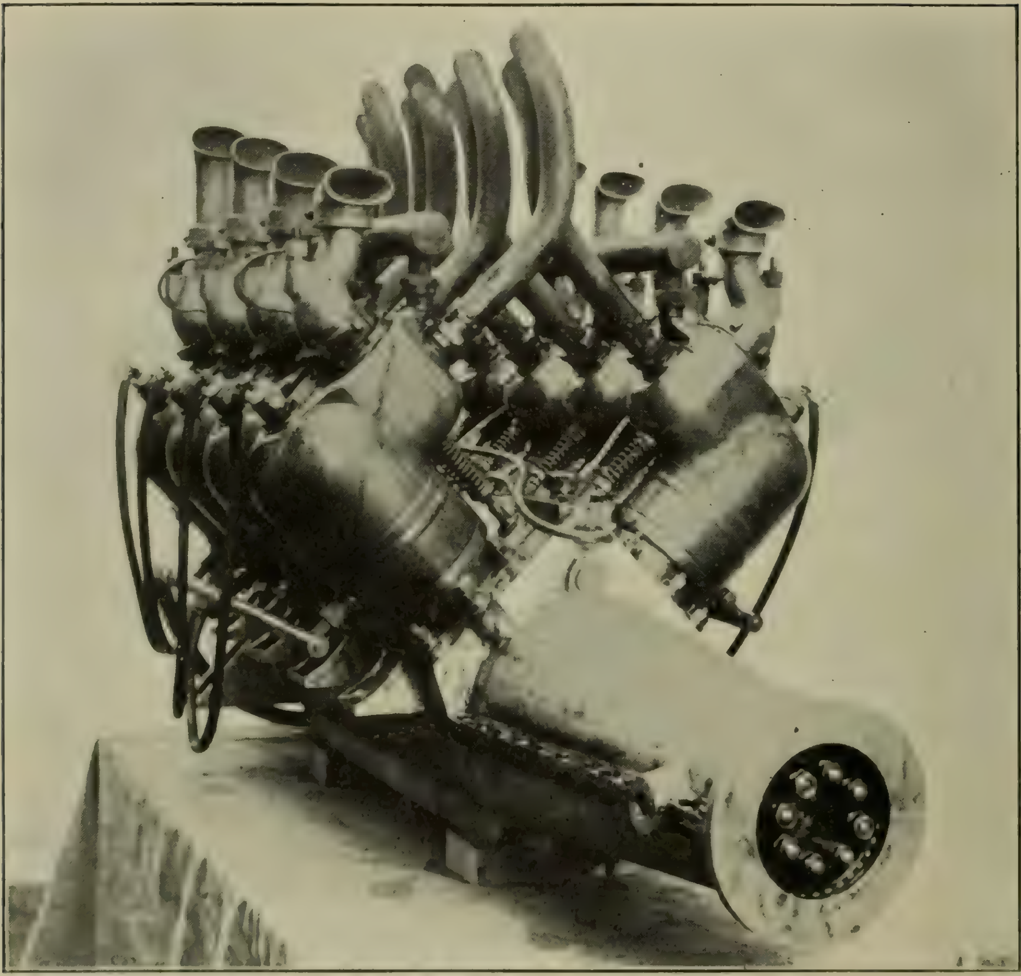


ANZANI 50 HORSE-POWER MOTOR.

from an ordinary carburettor, and the valves themselves are automatic spring poppets. The four sizes, of which No. 2 crossed the Channel with Blériot, are: 15 horse power, 3⅜ inches by 4 inches, 1,800 revolutions per minute, 3 cylinders, 84 pounds weight; 30 horse power, 4¼ inches by 5¼ inches, 1,600 revolutions per minute, 3 cylinders, 145 pounds weight; 40 horse power, 4¾ inches by 5¼ inches, 1,500 revolutions per minute, 3 cylinders, 172 pounds weight; 50 horse power, 5⅜ inches by 6 inches, 1,400 revolutions per minute, 230 pounds weight.

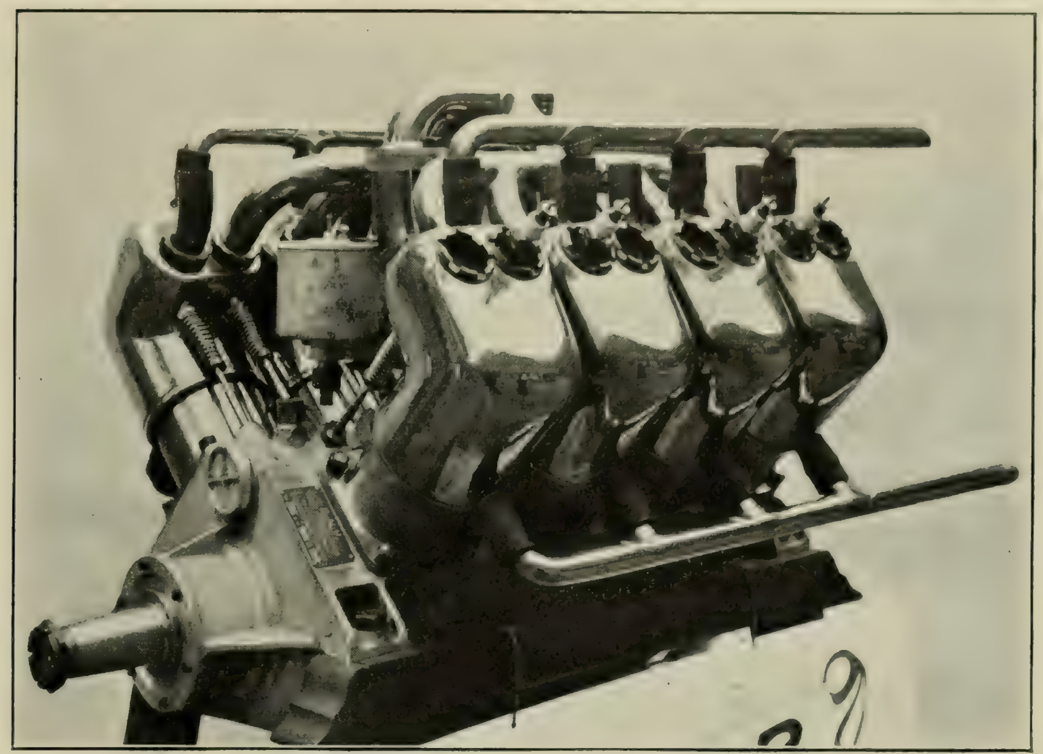
Specification:—Cylinders special cast-iron, in one piece with valve chambers and air-cooling vanes. Valves 5 per cent nickel steel. Pistons grooved, extra-light, machined hollow. Cranks forged steel. Axles of flywheel-crankshaft of refined nickel-steel, sweated and cemented into the flywheels. Flywheels in cast steel. Distribution without cam-shaft, by pinions engaging cams. Splash-oiling with ducts to all wearing parts. Automatic carburettor, without throttling gear. Ignition by 6-volt storage battery, or magneto. With it in *Blériot IX*, Blériot made the first cross-country run, stopping twice to adjust his apparatus, and flying altogether about 40 kilometres.

In *Antoinette IV*, Latham made his flights across the Channel, almost reaching Dover in the last of them, and, in *Antoi-*



ANTOINETTE 40 HORSE-POWER MOTOR.

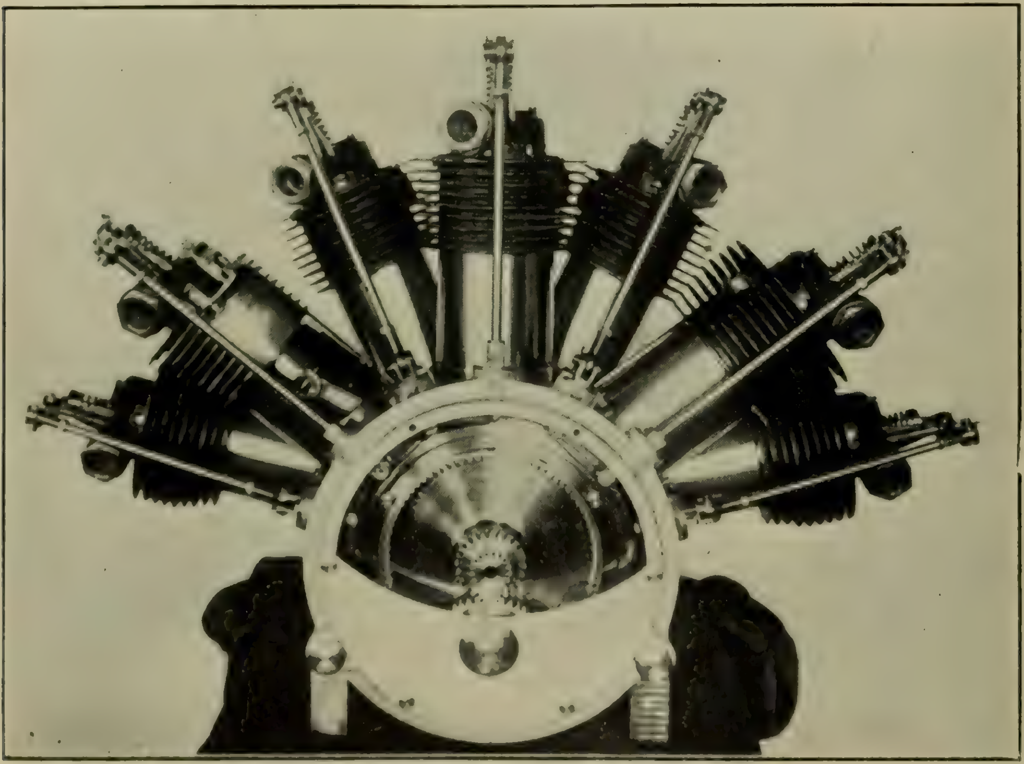
nette V, he made the French record of duration with the same motor. Later, H. Farman won the Grand Prix for distance and the world record for duration using an Antoinette 40 horse power in one of his aeroplanes. Later these records were all eclipsed by others, but during the last few months the Antoinettes have shown up splendidly in the various meetings in Europe. The motor is eight-cylinder, four on a side, arranged in a V of 90 degrees, each pair working on the same crank. With four cranks, there are always two cylinders doing work so the rotation is very uniform and the propeller answers for a flywheel. The cylinders and valve boxes are machined out of a single piece of steel so that the whole chamber of explosion is an integral piece, and the cooling jacket is of red copper, formed in one piece by electrolysis. This motor must of necessity have a separate radiator, as there is little opportunity to get at the interior cylinders with currents of air, so it is made of slender tubes arranged to form a plate about 2 feet high by 9 feet long and ½ inch thick. This only weighs 24 pounds, for 14 square yards of surface. There is no carburettor, but the mixture is forced into the cylinders by a pump. This motor is made in two sizes, 50 and 100 horse power, the only difference between them being that one has eight cylinders and the other sixteen. The bores are 4⅜ inches, stroke 4¼ inches, revolutions per minute 1,200, weights 192 and 330 pounds each.



E. N. V. MOTOR, 40 HORSE-POWER.

Another motor of very similar arrangement is the "E. N. V." made in 40 and 60 horse power. Blériot has one on his latest design, the *Blériot XII,* with one of which he made the sensational flights with a passenger at Rheims. In this motor the carburettor is used, and the exhausts are all separate at the top of each cylinder. It also has a water radiator. It further differs from the Antoinette in having both inlet and outlet valves mechanically operated by the lay-shaft, which is inside the case. It is made in two sizes, 40 and 60 horse power, the former 3⅜ inches bore by 3½ inches stroke, 1,500 revolutions per minute, 154 pounds weight; the latter 4¼ inches by 4⅜ inches, 286 pounds weight. Both motors have eight cylinders.

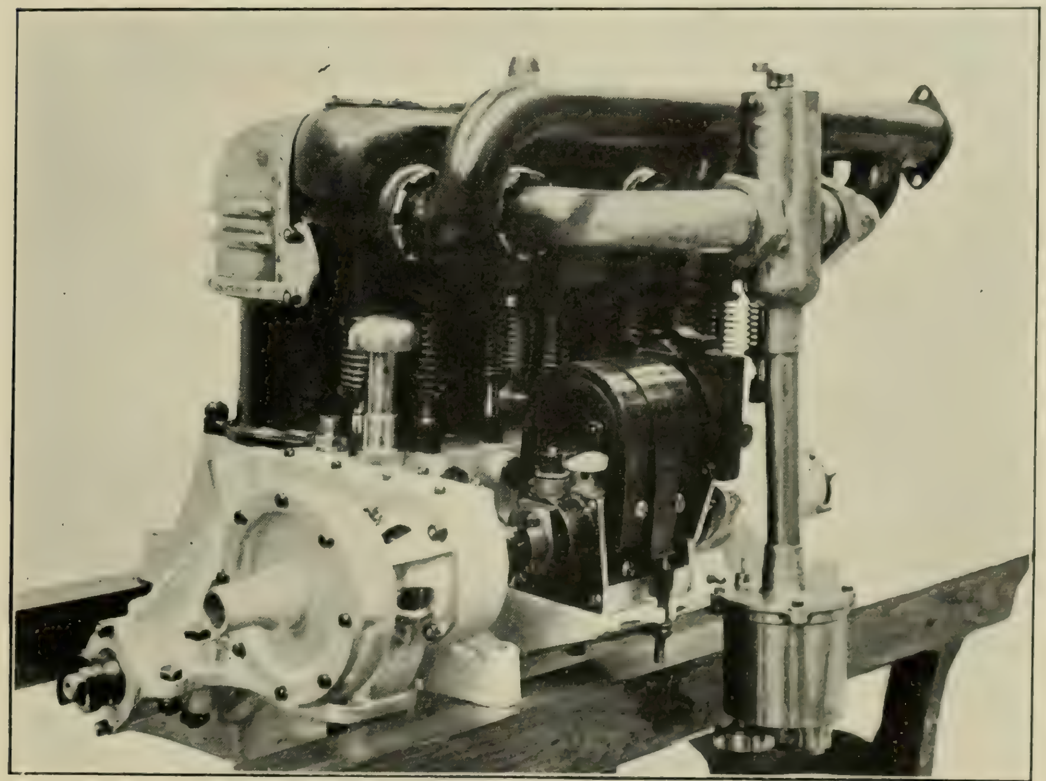
Among those of the ordinary type, with four to eight cylinders mounted in a row vertically above the crank case, that of the Clément-Bayard Company may be mentioned. The crank case in these is of aluminium, the cylinders cast in semi-steel and the cooling jackets in red copper. This motor is used in the *Demoiselle* type of Santos Dumont, the lightest, smallest, and fastest monoplanes in the world. They are furnished in two, four and six cylinders, in 20, 40, 100, and 200 horse-power sizes. The 20's and 40's are 4 inches by 4¾ inches, 1,500 turns, distribution by a lay-shaft inside the case actuating both inlet and outlet valves, cooling by a radiator and centrifugal pump, and oiling by drip-feed, forced by a pump in the crank case. The carburettor is constant level, arranged to operate at all angles, ignition by spark plugs. The weight of the 40 horse power is 242 pounds.



R. E. P. 60 HORSE-POWER MOTOR.

These motors have thus far roughly divided themselves into two groups, one cooling by air-vanes and the other by radiators. Still a third group is that in which the cooling is effected by ventilator fans, blowing on the cylinder-vanes, the fan at the same time acting as a flywheel. Of this class the most famous representative is the "R. E. P." constructed by M. Esnault-Pelterie, the president of the French Association of Aerial Locomotion, and inventor also of the R. E. P. Monoplane. It was with this motor that Maurice Farman obtained the world's record of the *Vol de Buc á Chartes.* It is on the market in three sizes, 20, 30, and 40 horse power, of five, seven, and ten cylinders respectively, all of 3⅜ inches bore by 3¾ inches stroke, and revolutions per minute maximum of 1,500. The weights are 82, 115, and 158 pounds respectively. The extreme lightness of these motors is obtained by careful design, and the selection of the strongest possible materials of construction. The cylinders are arranged in radial fans, of 3 and 4 cylinders, side by side, "staggered," acting on two cranks at 180 degrees. By this arrangement, there are always two cylinders working per revolution, or one impulse per stroke, giving very uniform turning moment. The exhaust and intake is managed for each cylinder by a single valve, which takes two positions under the action of the lay-shaft, connecting either the exhaust ports to the air, or the intake to the mixture pipes.

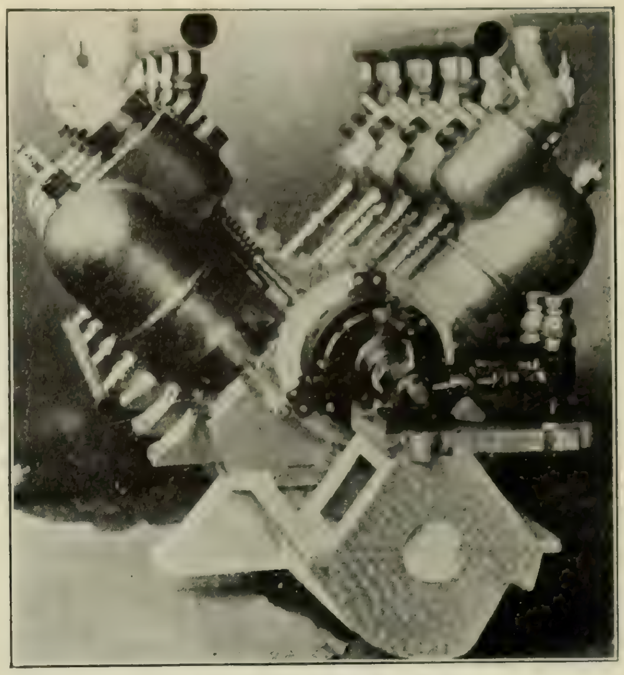
The matter of propellers is so intimately bound up with the engines themselves that some mention of those in use for aeroplanes seems almost essential in a description of types of motors. The first aerial screw was proposed and used by Leonardo da Vinci, the great artist, architect and man of learning of Italy, who, like Giotto and Michael Angelo, was too big for any one art to contain. After the fashion of most master-minds, he went right to the heart of the matter and pointed out the ideal screw propeller for air navigation, but it was centuries after before the little men around him could get away from the follies of oars, paddlewheels, windmills, and such primitive ideas that encumbered their minds, and it was not till 1834 that a series of Frenchmen finally developed the screw for balloon propulsion; fifty years thereafter, it approached the true helix under Dupuy de Lome,



CLEMENT-BAYARD 40 HORSE-POWER FOUR-CYLINDER MOTOR.

in 1872. Colonel Renard in 1888 published the results of his numerous experiments on the losses due to slip, etc., and the causes thereof, and gradually it became apparent that these should not exceed 30 per cent of the work of the motor in any well-designed screw. The development of the various types soon again evolved two classes—slow-speed and large diameter, and high speed with small diameter. At present both classes have their ardent adherents, but, in view of the conclusive results in favor of the slow speeds and large diameter, obtained by experiments with ordinary blast fans during the last few years, there is no doubt that the best results are gotten by the slow speed and reasonable diameter of propellers. The French never use two propellers, as in some American makes, principally because of the great danger that ensues when one of the screws breaks or stops, if there are two. They all vary in size between two and three metres, and 600 to 1,200 revolutions per minute. Specifically, the Voisin is 2.3 metres, 1,100 revolutions per minute; Clément-Bayard, 2.4 metres, 750 revolutions; Blériot XII, 2.7 metres, 580 revolutions; Farman, 2.5 metres, 800 revolutions. The principal problem at present is to get a strong, light material, which will not warp in the weather, will not fly to pieces under the centrifugal force, nor bend out of shape, and yet be light and shapely. You can buy them from the various aeroplane dealers in Paris, in solid wood; hickory and ash, glued up of sections of flat pieces; in black walnut, oak *fumée*, hickory and holly; or you can get them in solid cast aluminium finely finished, prices varying from $100 to $150 each. I think that when Americans get around to it, we will stamp them out of sheet steel in two pieces, and clinch-lock the edges.

A *résumé* of the aeroplane motors is appended below in the concise form of a table of comparative costs and weights per horse power based on the 50 horse-power size. It will be noticed that the Clément-Bayard is by far the heaviest, in spite of using aluminium for the case, thus adding to the already large mountain of proof that for equal strength steel is always lighter than aluminium. The table also brings out the increased cost necessitated by multiplication of cylinders, to obtain increased horse powers at light weights. The Anzani, with only three cylinders, is by far the cheapest, but its weight is about midway between the Clément and the Gnôme, the lightest of them all. Just why nothing has been done in the line of cylinders larger than 4½ inches by 5 inches, say four large cylinders in a cross, revolving about a central case, *á la* Gnôme, has not yet been satisfactorily answered by the French constructors. Possibly our own may



THE ANTOINETTE MOTOR.

show them a thing or two in this matter,—when they get going. The French are considerably exercised (aside from the patent disputes) over the size of the Wright motor, compared to their own. This is only 25 horse power, for an aeroplane weighing 470 kilogrammes, or about the same as most of the French, yet they always need a 50 horse-power motor, and so have to carry a good deal more gasoline to make the same records of duration and speed as the Americans. It cannot be explained by the difference in estimating "horse power," as the Wright motor is 4⅛ inches bore by 4 inches stroke, weighing 7.2 pounds per horse power, thus being the heaviest of them all. It is four-cylinder, and therefore only half the power of the eight-cylinder French motors of the same bore and stroke. They have finally ascribed the difference in horse power required to a combination of better propellers, absence of "feathering" and less skin-resistance of the Wright bi-plane, yet, as their aeroplanes are far steadier and better poised than the Wrights exhibited in France, precisely because they all have feathering and rear supporting planes at the end of equilibrium tails, they prefer to lose the horse power in return for greater steadiness.

TABLE OF FRENCH AVIATION MOTORS.

Make—	H. P.	Weight per h. p.	Cost per h. p.	Speed.
Antoinette	50	3.84 lb	$48.00	1,200
Anzani	50	4.6 lb	20.00	1,400
Gnôme	50	3.36 lb	52.00	1,200
E. N. V.	40	3.85 lb	37.50	1,500
Clément-Bayard	40	6.05 lb	47.50	1,500
R. E. P.	40	3.96 lb	70.00	1,500
Wright	25	7.2 lb	——	1,400

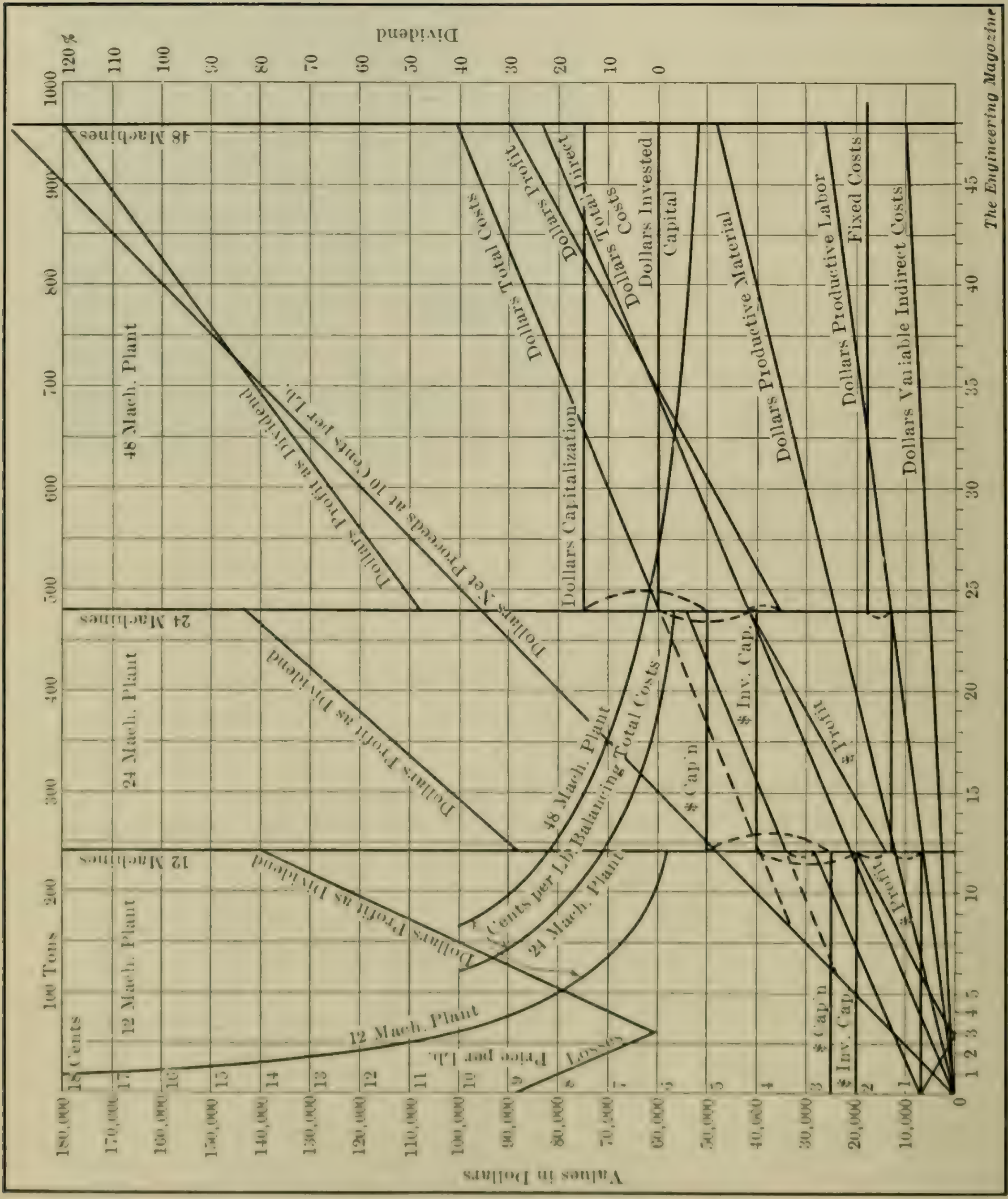


CHART OF MANUFACTURING PROFITS AND LOSSES AT VARIOUS RATIOS OF OUTPUT TO CAPACITY.

This chart is discussed in Mr. Hess's article following.

MANUFACTURING PROFITS AND LOSSES.

A STUDY OF RELATIONSHIP BETWEEN CAPITALIZATION, INVESTED CAPITAL, LABOR, MATERIAL, OUTPUT, AND SIZE OF PLANT.

By Henry Hess.

Last year the author gave a series of lectures before the graduating engineering class of Columbia University on matters connected with the building and operation of a manufacturing plant with a view to its final object of existence from the owners' or investors' standpoint—the payment of dividends. The Editors of THE ENGINEERING MAGAZINE have asked the author to explain his analysis in the following article. The method outlined has been found very useful by the author in his own actual practice and business, with various modifications, to elucidate various phases and changes in conditions. The basic principles and methods are applicable to business of any nature whatsoever, be that manufacturing, merchandising, engineering, architecture, etc., so long as costs are incurred and something sold, be that a tangible object, set of plans, or even advice.—THE EDITORS.

EVERY manufacturer, every business man and every professional man—every one intending to join their ranks—is of course more or less fully aware that in order to realize the final end for which the risks of business are undertaken—Profit—a careful comparison and following up of all elements of cost is absolutely essential.

But the commercial agencies report a fairly large percentage of failures. Many of these are due to such adverse circumstances as heavy losses through failure of related houses, panic times, etc. Still, by far the greater cause of trouble is failure to realize the relationship of the various cost factors to size of plant, to cost, etc., and, more important still, failure to realize a tendency toward a dangerous condition in time to apply the proper remedy. Too many awake too late from the notion that the keeping of a correct set of books, or even of an elaborate cost-keeping system, is all that is needed. These do contain all the elements, but merely as an array of figures, the relationship and interdependence of which and, more particularly, the trend of which, it is given to but few to grasp quickly and readily.

The difficulty of such oversight is resolved by resort to a diagrammatic presentation. As an example, assume a plant that is building a special machine (values cited herein are, naturally, only assumed to serve in illustration).

Following the usual practice, cost of product will be divided up into "Productive Labor," "Productive Material," "Variable Indirect Costs," and "Fixed Costs."

To Productive Labor are charged all items of cost of material directly embodied in the product sold.

To Variable Indirect Costs are charged all items that are directly proportional to the size of the output.

To Fixed Costs are charged all items that are less directly related to the size of output; such as foremen, office force, depreciation, interest, taxes, etc.

Variable Indirect Costs and Fixed Costs together make up what is usually termed "Burden," "Overhead Charges," etc. The division makes possible a closer analysis and recognition of the changes in cost due to an increase in output. To illustrate:

A plant will have to be provided even before a single machine is built. The consequent charges for taxes, interest, depreciation, are incurred whether ten machines or none at all are built. Such charges are Fixed Costs. On the other hand, fuel charges for power, oil, waste, material not entering directly into the machines, and similar items, will be zero when no machines are built; they increase in direct ratio with increase in output. Such charges are therefore Variable Indirect Costs.

In the diagram the vertical scale represents values in dollars and the horizontal scale size of output. At the base, size of output has been given in numbers of machines built; at the top the corresponding weight in tons is given as the scale.

Increase in output carries with it a proportional increase in Variable Indirect Costs, Productive Labor, and Productive Material. The lines representing these in the diagram will therefore all start from zero for zero output.

Increase in output does not immediately carry with it an increase in the Fixed Costs. On the contrary, these remain fixed over a range of output. In the case here illustrated $7,000 takes care of an output up to twelve machines (240 tons); this jumps to $13,000 from twelve to twenty-four machines (480 tons); a further increase to $18,000 will carry from twenty-four to forty-eight machines (960 tons). This is shown in the diagram by a series of horizontal lines labeled "Fixed Costs."

Summing up all of these cost items gives Total Costs, shown in the diagram by slant lines, so labeled; the break occurring at twelve and again at twenty-four machines is due to the increase in Fixed

Costs attending enlargement of plant, of supervising force, etc., at each such increase of output.

The output is considered as sold at a uniform price of 10 cents per pound. This is represented in the diagram by the slant line starting at zero labeled "Net Proceeds."

The difference between Net Proceeds and Total Costs is "Profit," if the Net Proceeds is the larger item. These profits are shown in the diagram by the slant lines so labeled. The break in these is due, as before, to the change in Fixed Costs occurring at twelve and twenty-four machines.

The profit line for twelve machines and less intersects the base at three machines. This indicates that the profit is zero at three machines. The continuation of this line is shown as a reversed slant. When no machines are built the consequent loss must equal the Fixed Costs for zero output; the reverse slant line therefore intersects the vertical scale at $7,000. It shows also that when only one machine is built the loss is slightly under $5,000. The Total Cost line for zero to twelve machines crosses the Net Proceeds line at three machines, indicating that, unless the plant can be employed at over 3/12 or 25 per cent capacity, its operation will result in no profit, or even in loss if the employment be less. The larger the plant the greater the number of machines that must be turned out to barely balance the cost. In the diagram this point is found at the intersection of the Net Proceeds line with the prolongation (dotted) of the Total Cost lines. For a twelve-to-twenty-four-machine plant this point it at six machines. For a twenty-four-to-forty-eight-machine plant this point is at eight machines.

It is very important to know at what lowest price competition can be met and yet realize a profit. As output of a given kind may generally be reduced to cost and price on the per pound basis, which basis is in fact frequently used as giving a convenient factor, that is here used for analysis and pictured in the diagram by the curves marked "Cents per pound" balancing "Total Costs."

For convenience sake the lines of change, or of plant increase, are marked by heavy verticals labeled "Twelve Machines," "Twenty-four Machines" and "Forty-eight Machines."

Taking the zero-to-twelve-machine plant section at the left end and following the curve to the vertical from three machines shows that the Total Costs are balanced by a price of 10 cents per pound. This must of course be so since the Net Proceeds at 10 cents per pound just balance (intersect) the Total Costs at three-machines output. Tracing upward from two machines to intersection with the curve shows that the costs are balanced at 12½ cents per pound; in other words, if only two machines are turned out these must be sold at 12½ cents per pound to avoid loss, and at more than 12½ cents to secure a profit.

Should competition be heavy, or should it be considered advisable to employ the plant up to its capacity, even though to do it should necessitate selling at less than 10 cents per pound, then again reference to the curve will supply the needed information. By building ten machines, 10/12 or about 83.3 per cent of full capacity, the net price may be reduced to 6.1 cents per pound to just balance costs; at full capacity (twelve machines) the costs would be balanced by a net price of 5.8 cents per pound. The twenty-four-machine plant turning out only twelve machines would have to realize net 7.1 cents per pound to balance costs (as found by the intersection of the second curve with the twelve-machine vertical at 7.1 cents). As the similar base price for twelve machines turned out by the smaller twelve-machine plant was only 5.8 cents per pound, a difference of 1.3 cents per pound, the importance of considering wisely and carefully the advisability of enlarging a plant is clear. Similarly the diagram shows that the same twelve machines when turned out by a plant capable of forty-eight machines, must be sold for at least 8.2 cents per pound or 2.4 cents per pound more than for the small twelve-machine plant. As this difference of 2.4 cents represents $2.4 \div 5.8 \times 100 = 41$ *plus* per cent of the cost of 5.8 cents, this emphasizes the point made. A matter of 41 per cent in the base sales price that just balances cost is a most serious handicap. In times of adversity, when prices are cut to the last notch, when the forty-eight-machine plant turning out only twelve machines sells these at absolute cost to avoid a shut down, the twelve-machine plant competitor, selling at the same actual price, yet realizes a profit of 2.4 cents per pound. By cutting the price to 7.1 cents per pound, or 1.1 cents below the cost of its larger competitor, the small plant is still able to realize a profit of 1.3 cents per pound.

To run a plant it is necessary to invest capital. Could that be turned over directly, in other words could the investment be realized on at the same moment that costs are incurred so that it would be unnecessary either to give or ask credit, then the investment would equal the Total Costs. A concern having a reasonable credit with its banks need not actually invest quite as much capital as will equal the total cost at maximum output. The proportion varies greatly with conditions of the money market, cash stringency, etc. In this case a capital invested of $20,000 has been considered for the twelve-machine plant. This is noted in the diagram by the horizontal line labelled "$ Inv. Cap." which rises to $40,000 for the twenty-four-machine plant and $60,000 for the forty-eight-machine plant. Intersections with the Total Costs lines show that in the three plants Invested Capital equals Total Costs at outputs of seven and one-half, fifteen and one-half, and twenty-four machines.

If no water is injected, no charge made on account of patents, good will, etc., then Invested Capital will agree in amount with the capitalization. Usually, however, the capitalization represents a larger sum than the actually invested capital. Occasionally, a business is found in which, through the investments of profits in the plant, the actual investment is larger than the capitalization. That is relatively rare in these days of the prevalence of stock corporations; practice rules to increase nominal capital to a point that will show a relatively small dividend.

In this example a capitalization larger than the invested capital is employed, the amounts being $25,000 for the twelve-machine plant, $50,000 for the twenty-four-machine plant, and $75,000 for the forty-eight-machine plant. These are indicated by the horizontal lines labeled "Capitalization."

It follows that to the stockholder, the matter of real and final interest is the profit expressed as a dividend on the capitalization. In the diagram this is shown by the slant lines labeled "Profit as Dividend;" the dividend scale is given at the right hand. As in the twelve-machine plant the Total Costs were balanced by the Net Proceeds at 10 cents per pound, when turning out three machines, it follows that dividends are zero at that output; below that output, there not only can be no Dividend, but there must be a loss. This is shown by the reversal of the "Profit as Dividend" line, labeled "Losses." At full output the dividend line intersects the twelve-machine vertical at 80 per cent. The Profit as Dividend line of the twelve-to-twenty-four-machine plant shows that when this larger plant turns out only twelve machines its larger apparatus and investment cuts the dividend down from the 80 per cent of the smaller plant to as little as 28 per cent for the intermediate plant. When this plant operates under its full capacity of twenty-four machines it realizes from Profit as Dividend 83 per cent. Enlarging to forty-eight machines gives, at full output, a Profit as Dividend of 120 per cent.

It is evidently worth while to make the necessary investments to run the largest of the three plants as the dividend is so largely increased by the operation of the various incidental economies possible. The shadow side of the larger plant has been previously shown as residing in the fact that the smaller plant, operated at its full capacity for an output representing but a small part of the capacity of its larger competitor, realizes a profit while the latter is incurring an actual loss. The wise manager will increase whenever he becomes reasonably convinced that a larger output can be sold for a considerable number of years; but he will be exceedingly chary of enlargement under the influence of a boom. The *business* may weather the difficulties when the boom collapses, generally by the aid of outside capital; whether the *original ownership* manages to retain the *control* of the business it has built up is far more problematical. To such original owners there can be but little satisfaction in the contemplation of the enlarged plant when this enlargement has caused it to pass from their control, and when refusal to enlarge would have retained it.

EDITORIAL COMMENT

Problems of Achievement.

A CORRESPONDENT whose opinion and criticism are worthy of much respect writes with earnestness his exceptions to an editorial in our August issue, entitled "Accident and Conquest," which formulated certain views as to probable limitation of achievement in aerial navigation—or at least as to the "conquest of the air" by the media now in use.

The editorial, he says, "most curiously resembles some I seem to remember having read, cavilling at the possibilities of what are now commonplaces of existence. Really, now, did you not write this for a joke: 'There is not now, as a treasury to draw from, such an enormous margin of mechanical knowledge as lay ahead of the inventor of the steam engine'? Why, we have hardly yet begun to see even the mere edge of the 'mysteries of the Kingdom of God.'

"The mail rider on horseback outdistances the foot messenger; the mail service by train outdistances the mail rider; the telegraph and telephone vastly outdistance the train, taking in each case the type of the highest development. The automobile and locomotive have outdistanced the horse at his best. It may be possible that the aeroplane will outdistance both of them.

"My idea simply is that there are possibilities in mechanics undeveloped which are now entirely beyond our ken, and to which our present developments will in future seem like the ox-team or the snail. The minute that we allow ourselves to think that we have arrived at the apotheosis of anything except individual types, such as the locomotive, or the automobile, or the horse, do we not interpose a mental obstacle to further progress?"

The sentence quoted by our critic, and the whole argument of the editorial from which it is taken, must of course be understood as limited to the problem at issue. We have perhaps as much faith as our querist in eternal progress, but not always in the same sense. In physical geography, for instance, we can not expect to continue indefinitely the curve of knowledge begun by the Phœnicians or Marco Polo. We shall go forward in knowledge of another kind, on a curve of different equation. Granting that the mysteries of the Kingdom of God are infinite, man's capacity for acquiring and utilizing physical science is finite, and if we have come any distance at all since the dawn of mechanics, our unrealized margin of achievement is by no means much reduced. The marine engine of 1825 used 10 pounds of coal and 60 pounds of steam per horse power per hour, while the Inch line steamers have been run on a pound of coal and 10 pounds of steam. Combustion motors that some of us can remember weighed 400 pounds per horse power, while the aeroplane motor of today weighs about 3 pounds per horse power. In electro-mechanical conversions we get an efficiency of 95 per cent easily. It is not a matter of opinion, but of fact, that we have but a small margin of unrealized achievement to draw upon here. Our statement was that in most of the mechanical and physical elements employed in aviation, the margin seems to be similarly small, compared to the enormous margin of unsolved difficulties that lies between the brilliant aeroplane performances of today and the real "conquest of the air"—a conquest as sure as that by which the "little cargo boats" may "sail the wet seas round."

In all the cases cited by our critic, and in any analogous ones we can recall, the achievement of a new order was secured by using an agency of a new order, an agency different not in degree but in kind. When human limitations had been all but reached, man turned to the horse —a motive power so different, so much larger, that even in its primitive performances it set new records; and then, by breeding and training, the horse was continuously improved. Next came wind, water, and steam—each in order of its own, even in crude form leaping easily to a new plane of performance on which it afterwards rose by successive refinements. So mechanical transmission gave way to electrical, and signalling to telegraphy—advances not of degree but of kind.

The horse handled very heavy loads, on rails, and attained a very high speed, when carefully bred and trained and placed upon a proper track; but no glorification of the race of horses would produce a power that could run the Twentieth Century Express, drive the Lusitania, or handle the commercial traffic of today. While the case is not closely parallel, we seem to be trying, in aviation, to do something like this. We seem to be attempting the solution of problems of a new order by the agencies of the old. It would be rash to assert that the problems will never be solved, but there does seem to be reason for holding that the forces and conditions to be met are of a new order, and that the practical conquest of the air depends on some achievement of a new order both as to power and materials.

In performances notable not for kind so much as for degree, the near future promises several items of interest. One is the removal of the old locks at Lockport, once regarded as one of the wonders of America, and their replacement by hydraulic lifts. Another is the raising of the Maine, for which an original plan is proposed by Mr. John F. O'Rourke. He would build wharves of piling parallel with the sunken hull on both sides, sink six pneumatic caissons between each wharf and the ship, and drive many small tunnels beneath the keel, from caisson to caisson. Through these tunnels cables would be passed, suspending the hulk on a system of slings placed a few feet apart. By tautening the cables by screw-jacks worked by hand the vessel would be raised "completely out of the water, where a complete inspection of her hull would be possible. Once above the water line, the gap between the wharves would be bridged and the engineers would work under and around the hull. When repaired she could be let down into the water by a reversal of the process. After being relaunched she can leave Havana harbor under her own steam."

It is said the plan will be referred to a board of Army engineers, for full consideration. It certainly is interesting, and if feasible, would permit such examination of the hull as could be secured in no other way, settling finally the cause of the melancholy disaster. It would seem, however, to invite serious difficulties from conditions characterizing the harbor bottom. The vision of the Maine returning "under her own steam" is perhaps remote. After the explosion and twelve years at the bottom of Havana harbor, the services of a well-equipped dockyard in close proximity would certainly be needed before the ship could steam, or even float.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ELECTRIFICATION OF RAILWAYS.

THE IMPERATIVE NEED FOR THE SELECTION OF A SYSTEM FOR UNIVERSAL USE.

George Westinghouse—American Society of Mechanical Engineers.

THE share of Mr. George Westinghouse in the development of electrical machinery on the one hand, and of railway apparatus on the other has been such as to make any opinion he expresses concerning the problems of railway electrification of transcendent interest. In a paper read at the recent joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers he deals with the standardization of the electrical equipment of railways, a subject which has been under active discussion for some years past. Mr. Westinghouse believes that the time has come when the adoption of a universal system of electrification is imperative; his paper is a plea for the "early selection of a comprehensive electrical system embracing fundamental standards of construction which must be accepted by all railway companies in order to insure a continuance of that interchange of traffic which, through force of circumstances, has become practically universal, to the great advantage of transportation companies and of the public."

The fundamental requirements to insure interchangeability of traffic in steam operation are five: (*a*) a standard gauge of track; (*b*) a standard or interchangeable type of coupling; (*c*) a uniform interchangeable type of brake apparatus; (*d*) interchangeable heating apparatus; and (*e*) a uniform system of train signals. Electric operation introduces three further fundamental requirements: (*f*) a supply of electricity of uniform voltage and periodicity; (*g*) conductors uniformly located with reference to the rails; and (*h*) uniform apparatus for control of electric supply.

The development of systems for the electrification of railways has followed the demonstration of the properties of alternating currents, of the steps in which Mr. Westinghouse gives a brief historical review. Three important systems have been put into practical operation, all using alternating current wholly, or in part. These are: (*a*) the continuous- or direct-current system (commonly called the "third-rail" system), which employs alternating current for transmitting power when the distance is considerable; (*b*) the three-phase alternating-current system with two overhead trolley wires; and (*c*) the single-phase alternating-current high-tension system with a single overhead trolley wire. The power-house equipment is essentially the same in the three system, but the systems differ in the kind of motors and controlling apparatus used and in the methods and apparatus for current transmission.

The essential requisites in a railway motor are ability to start under load, rapid acceleration, and ability to operate continuously at any desired speed or speeds. The capacity of the steam locomotive depends upon its boiler capacity; that of the electric locomotive on the capacity of the motors, which is usually fixed by the heating of their coils. The three types of motors have certain fundamental differences in speed performance which are important factors in determining the advantages, disadvantages and limitations of the several systems. The direct-current series motor automatically adjusts its speed in accordance with the load, the speed with any given load being definite, dependent upon the voltage applied to the motor. The speed may be decreased by the insertion of resistance in the motor circuit, a wasteful and inadmissible expedient, or by connecting two or more motors in series. As the system of current supply involves a fixed voltage, however, no speeds much above the maximum for which the motor is designed can be obtained. The three-phase motor, on the other hand, is inherently a constant-speed machine; by no means can the speed at light load be made appreciably higher than it is at full load. Speed can be reduced, however, by either of the methods noted above, or by special arrangement of the motor, although the latter method involves some complication in windings and connections. Three-phase motors have the advantage that on descending grades they may be used as generators, returning power to the line.

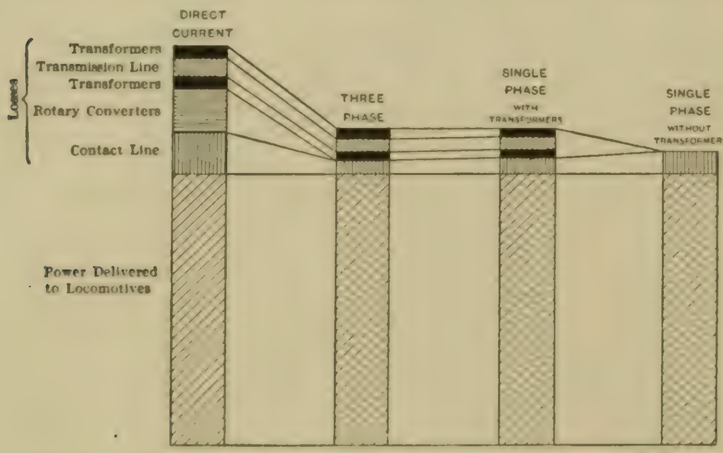


FIG. I.

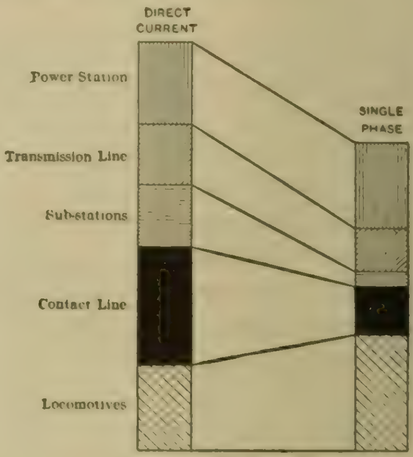


FIG. 2.

The speed characteristics of the single-phase motor are very similar to those of the direct-current motor, the speed at a given load depending directly on the voltage. The voltage, however, is not limited to that supplied by the circuit, or to one-half or one-quarter of that voltage, as in direct-current motors, but may be adjusted to any desired degree of refinement by means of auxiliary connections from the secondary winding of the transformer on the locomotive. The wide range of efficient speed adjustment, both above and below the normal, is one of the especially valuable features of the single-phase system. The choice of frequency for use on single-phase railways is one of the most involved, difficult and important problems now presented for solution. Twenty-five cycles is the rule for power transmission. This frequency has been adopted on nearly all the single-phase railways now operating. The Midi Railway of France, however, has adopted fifteen cycles, the frequency employed in nearly all three-phase systems. The lower frequency permits of a marked reduction in the size of the motor for a given output.

The controlling factor in the cost of electrification in nearly all cases is the system for transmitting power from the power house to the locomotive, and not the locomotive itself. In ordinary practice alternating current is generated no matter what the system. In the direct-current system the apparatus intervening between the generator and the locomotive, through which the energy must pass, are: (*a*) raising transformers in groups of three; (*b*) a three-wire transmission line and substations, which require attendance, containing (*c*) transformers in groups of three and (*d*) rotary converters; (*e*) a third-rail contact conductor which for heavy work must often be supplemented by copper feeders; and (*f*) the track return circuit, provided with heavy bonds, which must be supplemented in certain cases by feeders and so-called negative boosters. The alignment of the third rail must be maintained within close limits both in its distance from the track rails and in its elevation above them, as the contact shoe can have only a small range of automatic adjustment.

The three-phase system requires no rotary converters, the track return usually requires only inexpensive bonding, and the contact system consists of two overhead wires. Otherwise the transmission apparatus is the same as for the direct-current system. The contact wires require a double system of overhead construction, as they must be kept separate and well insulated from each other. The two wires must be maintained at equal height above the track and at switches and cross-overs the construction is complicated. In the single-phase system there are: (*a*) a raising transformer; (*b*) a two-wire transmission line and substations widely spaced, each containing (*c*) a lowering transformer supplying (*d*) a single trolley wire; and (*e*) a track return, usually requiring only inexpensive bonding. In cases where the distance from the power station is not more than 15 to 20 miles, the trolley wire can be supplied directly from the power house. The single wire permits a relatively wide range in height, as the pantagraph trolley automatically adjusts itself to the position of the trolley wire.

The three types of railway motors and the corresponding transmission systems have all successfully demonstrated their ability to operate railway trains. It is not Mr. Westinghouse's purpose to urge the adoption of any particular system, but to point out the characteristics of the systems which have a bearing on their limitations and adaptability to railway conditions, and to urge the gain which will result from a single universal system. He enumerates five prime requisites of a satisfactory universal system:

(*a*) The electric locomotive should be capable of performing the same kinds of service which the steam locomotive now performs. It will do this most easily by practically duplicating the speed and power characteristics of the steam locomotive. The wide range of performance will call for wide variation in tractive effort and in speed.

(*b*) The electric locomotive should be capable of exceeding the steam locomotive in its ability to haul heavier trains and loads and to operate at higher speeds.

(*c*) The electric system should adapt itself to requirements beyond the ordinary limitations of the steam locomotive in small as well as in large things. It should be adaptable to use on branch lines, and to light passenger and freight service similar to that so profitably conducted by interurban electric roads.

(*d*) A universal system requires that power should be transmitted economically over long distances.

(*e*) The contact conductor should be economical to construct for both light and heavy service; it should impose minimum inconvenience in track maintenance, give minimum probability of disarrangement in case of derailment or in snow and sleet storms, and in general be so constructed as to insure to the highest degree possible continuity of service.

"The use now made of electricity in steam-railway service has been brought about, generally speaking, through compulsion. The steam locomotive has reached its limitations and has been found unsuitable and inadequate in tunnels or in terminal service. Even where other considerations may have been controlling, the problem has usually been a specific one of electrifying a relatively small area. The problem has been solved by considering those factors which were of immediate importance, without giving weight to uniformity with other systems or to extension. Now the natural course of development will be the extension of these limited zones, until after a time they meet. Then there will arise great inconvenience and expense if the systems are not alike. In the early days of railroading, it was of little consequence whether the tracks of the different systems in various parts of the country were alike or unlike, but later it did make a vital difference, and the variation resulted in financial burdens which even yet lie heavily on some railways. It is this large view into the future of electrical service which should be taken by those responsible for electric railway development."

Complete electrification of a railway

ing practice; elimination of coaling and watering places, different composition of passenger trains, more frequent operation, heavier trains, higher speeds and the introduction of through service on branch lines will give rise to many new problems. Freight will be moved in much heavier trains than are possible with the steam locomotive. A large percentage of shunting operations due entirely to the use of steam locomotives will no longer be required.

With the adoption of a universal system the railway companies can effect large savings in capital expenditures by the adoption of some co-operative plan for the generation of electricity. They can utilize their own rights of way for the transmission of current, not only for the operation of trains but for many other useful purposes. The reduction of the cost of generating electricity through the development of gas and oil power will accelerate the work of electrification.

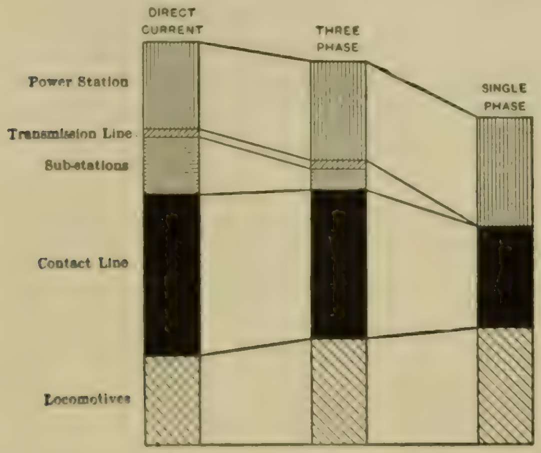


FIG. 3.

Mr. Westinghouse perceives that there will be serious difficulties to surmount in the selection of a general system. Each of the existing systems will have its partisans, there will be many advocates of the common view that there is room for several systems, controversies on minor details will cloud the main issue. If there were only one system to be considered, however, there would be a concentration of energy on the perfecting and simplifying of the apparatus for that system, to the advantage of both railway companies and manufacturers.

Five appendices are added to Mr. West-

single-phase system on the New York, New Haven and Hartford Railroad. The second gives detailed data and many photographic illustrations of American designs of locomotives for heavy service. In Appendix III the three systems of electrification are compared; diagrams show the arrangement and apparatus of transmission circuits and substations, and the comparative losses and first and operating costs of the three systems. Appendices IV and V give, respectively, data of existing electrified steam roads and electric roads for trunk-line operation, and a brief review of the early history of the single-phase railway motor.

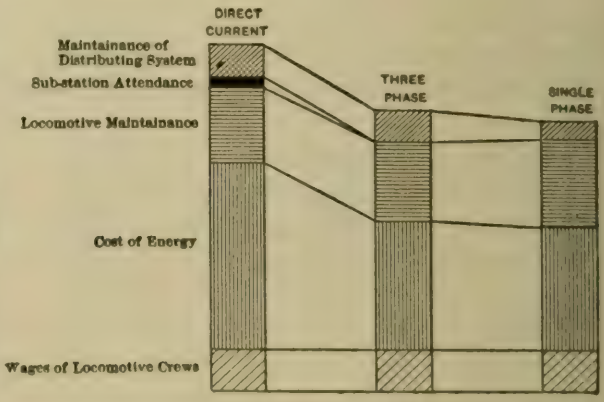


FIG. 4.

The diagrams reproduced above are taken from Appendix III. Figure 1 shows the comparative losses between the generators and the locomotives for each of the three systems, in a class of service where the input to the locomotives by the several systems is practically the same. Figure 2 shows the comparative first costs of the direct-current and single-phase systems for 100 miles of single-track railway with through and local freight and passenger traffic handled by 20 locomotives. Figures 3 and 4 show, respectively, the first cost and the operating cost of the three systems for a special case of pusher service on mountain grades employing 12 locomotives. The line is 32 miles long, part single track, part double track and part triple track. Including a large yard, there are 90 miles of single track. The generating station is so located that substations are necessary with direct and

ELECTRO-MECHANICAL LOCOMOTIVES.

A BRIEF REVIEW OF SYSTEMS OF ELECTRO-MECHANICAL PROPULSION FOR LOCOMOTIVES ABOUT TO BE PUT TO PRACTICAL TEST.

A. P. Chalkley—Cassier's Magazine.

WE noted in these columns in our July issue that electro-mechanical marine propulsion is soon to be given a trial on a considerable scale. From a brief article by A. P. Chalkley in *Cassier's Magazine* for June we learn that similar progress is being made in the application of electro-mechanical propulsion to locomotives. Mr. Chalkley estimates the saving in operating cost of the electro-mechanical system using steam turbines at 32.5 per cent., and using Diesel engines at 37 per cent., over the reciprocating steam locomotive. We quote from his description of the three leading systems, of which at least one, the Reid-Ramsay, has already been put to practical test.

"In 1905 a system was patented by Mr. McNulta, which apparently has never been put into practice, but which possesses great originality. Two vertical turbines of the Parsons type were coupled to the external armatures of alternators, the internal field magnets being keyed on to shafts revolving within the turbine shafts and coupled to two driving axles of the locomotive through bevel gearing. There were also motors on the other axles, taking their power from the secondaries of static transformers, the primaries of which were connected to the terminals of the alternator armatures. The field magnets of the alternator were excited from a separate steam-driven exciter. On starting up the turbines, the outer armatures were rotated, and when the field magnets were excited current was generated in the armatures and delivered to the motors through the transformers. The field magnets also revolved, and, as the speed of the locomotive increased, the relative speed of rotation of the magnets and the armatures decreased, and the voltage at the armature terminals (and consequently the torque of the motors) diminished, that is to say, the highest torque was developed at the start and was reduced as the speed rose. Variations of torque, according to the conditions, were obtained by a controller, which altered the ratio of transformation.

"Probably the first electro-mechanical locomotive to be built has been constructed at the works of the North British Locomotive Company at Glasgow, in accordance with the designs of Messrs. Reid and Ramsay, and tests have recently been carried out. A single horizontal turbine of the Curtis type is employed to drive a direct-current series dynamo, from which power is taken to four or more series-wound motors coupled to the driving axles through gearing in oil boxes. The steam, after passing through the turbine, enters a jet or ejector condenser, where it is condensed and mixes with the condensing water. The whole is then pumped by means of turbine or reciprocating pumps through the cooling apparatus mounted on the front of the engine, so as to obtain the full blast of the air when the train is in motion. Cooling may also be facilitated by a turbine-driven fan, forcing the air over the water, the same or another fan being used to cause a draught in the boiler furnace. The water, after being cooled, drops by gravity into a supply tank, and part is pumped back into the boiler through a feed heater, and part used for condensing purposes again, the supply tank being of sufficient capacity to carry the water required for the boiler and to make up any condenser losses.

"A further and most promising system which will soon be put into operation is that of Mr. Durtnall. It is applicable with steam turbines, suction gas engines, or Diesel oil engines, though the latter seem likely to give the best results. The generator consists of two elements, the alternator, with armature and field magnets and the transformer generator. Squirrel-cage induction motors are all used on the axles. Both the rotating elements of the generator are on the same shaft, which is coupled to the prime mover; an exciter delivers current to the field through the slip rings. The design of the machines depends on the conditions of running and the speed required. If the prime mover is a Diesel engine working at, say, 400 revolutions per minute, the alternator may be a 4-pole, the transformer a 12-pole, and the motors 20-pole machines. To obtain the lowest speed of the motors, the current is taken direct from the armature of the alternator to them, when a synchronous speed of 80 revolutions per minute is produced. For the next speed the current, instead of passing direct to the motors, is led to the primary of the transformer generator, so that the flux due to it revolves in a direction contrary to that produced by the rotation of the primary itself. The periodicity of the current taken from the secondary of the transformer generator is, therefore, equivalent to that of an alternator with 12 minus 4, i. e., 8 poles, so that the synchronous speed of the motors is 160 revolutions per minute. The third and top speed is reached by sending the current into the transformer generator, so that the direction of rotation of the flux due to it is the same as that of the primary of the transformer generator. The synchronous speed of the motors is now the same as if the power were obtained from a 12 plus 4, i. e., a 16-pole generator, and will be 320 revolutions per minute. Intermediate synchronous speeds can be obtained by mounting the armature on bearings, and providing it with a pair of slip rings, and varying the speed mechanically to any required extent. Reversing is accomplished by simply reversing two phases by means of a change over switch. The figures given above are, of course, purely illustrative, and it would probably be found in most cases that higher speed motors would be more satisfactory and economical, gearing being employed to reduce the speed of the axles to the workable limit."

THE ENGINEER'S DUTY AS A CITIZEN.

A PLEA FOR THE ACTIVE PARTICIPATION OF ENGINEERS IN PUBLIC AFFAIRS.

Rear-Admiral George W. Melville—American Society of Mechanical Engineers.

ENGINEERS have begun to demand for their profession the recognition to which it is entitled by reason of the predominance of scientific progress among the influences affecting the advance of human civilization. They commonly forget, however, that rank has its obligations, that public recognition imposes public duty. It cannot be too often reiterated that engineers should accept as a part of their professional duty the obligation to participate in the discussion and administration of public affairs when sound technical knowledge is essential to the formation of a correct judgment by the public.

In a recent address before the American Society of Mechanical Engineers, Rear-Admiral George W. Melville cites a number of recent cases in which the civic duty of the engineering profession is plainly apparent. "In view of the enormously important part which the engineer plays in the life of today," he says, "it is incumbent upon him, more than upon most other men, to take a vital interest in the work of government and to lend his trained ability and judgment to its perfection. I do not mean, of course, that the engineer should do routine professional work for the government without compensation, but that in the discussion of public improvements and the administration of governmental departments, he should take an active public stand to influence and guide the non-expert part of the population.

"It is notorious that enormous amounts of money have been squandered on great public works because they were undertaken in a way which every engineer knew must be inefficient and uneconomical. If all of us as engineers had a keen sense of our duty in this respect, and would properly utilize our experience and ability through the daily press, the magazines and the reviews by public discussion and in the daily intercourse of life, as well as by impressing the truth upon our representatives in municipal and national affairs, I believe we would accomplish an immense good.

"A problem of foremost importance at the present time is the management of labor to secure efficient work and satisfied men. It is probable that the direction of more than 90 per cent. of the skilled labor is in the hands of engineers. Most emphatically is this a case where engineers owe a great duty to society. It would be inappropriate in this brief address to attempt a detailed discussion of the labor problem, but I feel that I shall voice the sentiment of every one present when I say that the effort of every American should be exerted to maintain absolute freedom of contract in labor matters as in all others. Just as we are opposed to monopoly by capital, so we are to the same thing by labor.

"No reasonable man objects to labor organizations, as such. They have undoubtedly been the cause of much benefit to the men. The danger with them, as with political organizations, is the formation of a machine which utilizes the organization solely for the selfish interests of the members of the machine. There can be no doubt whatever that many strikes are against the real wishes of a majority of the men, who are overborne by the machine and its adherents; and it is also true that the net result of nearly all strikes is an actual loss to the men. The problem is an exceedingly difficult one and requires the greatest wisdom, patience and tact for its complete solution; if, indeed, taking human nature as it is, we can ever hope for its removal from the list of worries of the manager of great enterprises.

"Many questions prominently before the public are peculiarly such as require engineering knowledge for their proper understanding and regulation. The word trust has come to have such a sinister meaning that it is only necessary to fasten it upon an enterprise to render it criminal in the popular estimation. We have recently heard a great deal about the so-called Water-Power Trust, the charge being that all the available power sites were being grabbed so as to subject our citizens at some future time to the payment of tribute for electric power derived from them. I am not concerned, at the moment, with a

deprecate, but to point out that engineers know these water powers cannot be made available except by the expenditure of large sums of money. Indeed, it would be easy to point out the fortunes that have been lost in the attempted exploitation of these supposedly lucrative natural gifts. The general public is utterly misled by statements that these power sites are obtained for nothing, the idea being that the development is a matter of small expense. Here the engineer can do a work of real benefit by disseminating correct information.

"Again, in the consideration of public-service corporations, the engineer knows the cost of installation and operation, and so can discuss intelligently whether rates are fair or exorbitant, and whether capital represents real investment or water. These are problems of the greatest importance, and for their proper solution, the electorate needs training that can be given by no one else so well as by the engineer.

"About a year ago, at our Washington meeting, I did what I could along this line by pointing out mistakes in connection with navy yard organization, and this illustrates very clearly what I am advocating for all engineers. Here was a great department of the Government for which the annual appropriation now exceeds $100,000,000. Its administration had fallen into the hands of a man who started to make changes in the entire administration which would have been ruinous to efficiency; and yet, hardly a voice was raised in opposition. I even heard of a case where one of our leading engineering journals refused to publish a criticism of this system submitted to them through a man whom they knew and esteemed most highly, but who stated that the author was so situated that he could not permit his name to be used. Not only would the magazine not print the article, but they did not take enough interest in this most important subject to study it for themselves and comment upon it.

"I do not mean to imply that engineers never show public spirit in such ways as I have suggested; there are too however, are mostly cases of unusual importance and relatively infrequent. What I am pleading for is a habit of mind that will cause engineers to take an active part in all public questions, great or small, where their knowledge and experience will enable them to contribute to the common good.

"The movement which has been set on foot by Congress to establish a Bureau of Mines suggests an opportunity for the engineer to take an active part in public affairs. I question whether this idea might not be developed a little further by providing for a department with a Cabinet officer at the head, to be called the Department of Mines and Manufactures, with the scope implied by the title.* When we think of the enormous values represented by the industries which would come within the purview of such a department, it seems only reasonable that they should be under the care of a Cabinet officer. If we are told that there is already the Bureau of Corporations, I would point out that the object of this proposed new department is quite different from that of the existing bureau which thus far, in the estimation of many, has done little or nothing to advance the interests of manufacturing, but has, in their opinion, disclosed a spirit which is almost inimical. The department that I have in mind would aim to stimulate improvement and progress in manufactures and industries generally, in somewhat the same way that the Department of Agriculture has done for the farmers.

"We have often heard engineers complain that the profession did not receive due praise and credit for its splendid work. This is true enough, but is the reason not very largely because the engineer hitherto has been content to do the work and then fade into the background, leaving the talking and the management to the lawyer and the politician? With the advance of technical education, engineers are more and more becoming the high officials of our large corporations. It is to these men, whose talents and trained ability have made them the leaders in manufacturing and in business, that the country has the right to look for leaders in the affairs of government, and not until the engineer of all grades has done his part towards the promotion of the highest efficiency of the Government can he truly say that he is, in the fullest sense, a good citizen of the Republic."

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* Since this address was prepared, the bill in Congress referred to above has become a law. The newspapers have published an item that consideration was being given to the formation of a Department of Public Works. This is along the same general line as my suggestion above for a Cabinet officer to head a Department of Mines and Manufactures.

THE VALUE OF WATER POWER.

THE EFFECT OF RECENT ENGINEERING PROGRESS ON THE VALUE OF WATER POWER.

Engineering News.

AN editorial article in *Engineering News* for June 23 directs attention to a phase of the long-debated question of the value of water power which is commonly overlooked. In the opinion of the writer, by the public at least and probably by a large part of the engineering profession as well, there is not sufficient appreciation of the effect which recent developments in mechanical engineering have had upon the value of water powers. The prominence of water power in the conservation movement lends the subject an importance quite apart from its technical interest; we

"The value of undeveloped water powers is to-day much less than it was 15 or 20 years ago. The cause of this decrease in value of water power is the great reduction in the cost for which power can now be developed by other prime movers. This fact is one of great public importance, and one on which the public ought to be informed. There never has been a time when the development of water power has been more prominent than at the present time. It is one of the most important features of the so-called conservation movement. The claim is made that the undeveloped the states or the nation are of such vast value that they should not be allowed to pass into private hands in perpetuity, but should be leased under reasonable restrictions, and the title to them should be retained by the public.

"We have in the past expressed general agreement with this view, which is held, we believe, by many members of the engineering profession; but it ought to be understood that the importance of public control of water power is in the distant future rather than in the present. It ought to be more clearly understood that in most locations and under most circumstances it is exceedingly difficult to develop water power and make a good profit on the capital invested. Any public revenue derived from water powers will have to be merely nominal for many years to come, or their development will be greatly hampered.

"Again, it is important that investors should know the real situation with reference to water-power values. The prevalent idea appears to be that the development of a water power is a process of obtaining something of value from Nature without paying for it. The average investor contrasts the fact that with a steam plant, coal must be steadily fed under the boilers and paid for at so much a ton, while with a water power plant the natural flow of the stream constantly turns the wheels. He concludes, therefore, that water power is necessarily cheaper than steam power. He has no understanding of the other elements which effect the problem and which extremely often reverse the comparison.

"The public belief in the great value of water power has been made the basis of a great state enterprise, and it is even proposed that the nation shall become concerned in great water-power development schemes. The State of Illinois has voted $20,000,000 for the creation of a deep waterway from Chicago toward the Mississippi River, and the voters have been given to understand that the water power incidentally developed by the construction of the waterway will be so valuable that it alone will repay the cost of the work. The promoters of great schemes for inland waterways have as one of the stock arguments in their campaign the claim that the great value of the water power developed will repay to the public a large part of the cost.

"Still again, knowledge as to the true value of water power is of great public importance from quite a different point of view. Cities throughout the country, great and small, are engaged in the increase of their water supplies. In many cases it becomes necessary in this work to reduce the flow in a stream which has been used or may be used for power development. The value of water power in such cases becomes often a matter which must be settled by litigation. If the values frequently adopted in compensating the owners of these water powers were the true values, then indeed all the glowing claims of the water-power promoters' prospectuses would be justified, as would all the claims of those who urge the extremest doctrines of conservation. In our opinion, however, most of the awards for damages in water-power cases are much beyond the actual value of the plants taken.

"The development of electric-power transmission some 20 years ago gave a great impetus to water-power development, and made available many powers which had hitherto been practically worthless." . . . But "while the electricians have been busy with long-distance transmission, and the hydraulic engineers with water wheels, development has been going on in other prime movers. The steam turbine, on the one hand, and the internal-combustion engine on the other are the two machines which have well-nigh revolutionized the field of power development in the short space of years since long-distance transmission brought water powers again into active development."

The steam turbine in its first development was not a highly economical heat engine, but in its very recent development, in large units, it is demonstrating itself to be almost certainly the motor of the future. It has the great merit, moreover, of keeping up its economy over a large range of loads. A combined plant of steam engines and low-pressure turbines in New York shows an average steam consumption of 14 pounds of steam per kilowatt-hour. Such a steam economy as this makes the cost of fuel a comparatively small element in the yearly power bill. The cost of attendance is one of the heaviest items in the cost of power production, and the steam turbine requires small attention. Another great advantage of the steam turbine over all other commercial prime movers is the great reduction in the cost of the generator.

Recent improvements in steam boilers have increased the size of units, improved economy, introduced superheating and automatic stoking and eliminated smoke, but the most important progress has been made in the ability to carry overloads. It is just here that the steam-power station shows to greatest advantage in comparison with the hydro-electric plant. The steam station is frequently designed to carry, for a short time, loads 50, 75 or even 100 per cent. higher than those for which it is normally designed. The water-power plant, on the other hand, on account of the inherent limitations of its machinery, can carry only a small percentage above its normal rating.

"It may be asked how the case stands for small-sized powers, such as those which are commonly met with in the condemnation of water powers by reason of the development of city water supplies. Admittedly, such small water powers, when advantageously located, are often worth a greater sum per horse power than the powers of great size which, if developed at all, must be developed in competition with the large steam-power stations. . . . . For small powers, however, the gasoline engine has practically rendered the steam engine obsolete. For larger powers, the oil engine and the gas engine using producer gas are rapidly gaining in popular favor. The fuel economy of these engines is so excellent that the total cost of fuel per horse power per annum is cut down to a figure nearly as low as that of the highest-class steam-power plants. . . . .

"Thus far, we have been speaking chiefly of the value of undeveloped water power. It ought to be said in addition that the cost of developing water power is very commonly underestimated by the lay public. The old-time development of water power on a small scale for the sawmill or the gristmill was comparatively inexpensive, but was correspondingly inefficient and liable to injury by flood. For a really substantial and reliable development of water power on either a small or a large scale, with proper provision against damage or interruption by floods, and with storage to provide for seasons of low water, it will be found that the cost of water power development per kilowatt or per horse power will almost always be largely in excess of the cost of installation of a steam- or gas-power plant of similar size. This additional investment cost creates an interest charge, which will often offset or more than offset the cost of the fuel for the competing plant.

"Nor is the case against the water power plant all summed up in the above. There are in the steam-power plant waste products in the form of heat, which is often necessary for use in manufacturing processes and must always be supplied, to a greater or less extent anyway, in winter weather. The water-power plant must be debited with this necessary fuel cost in order to compare it with its competitors on an equal basis.

"We have already shown that in nearly all cases where water power is developed on a large scale, the power must be electrically transmitted over long distances, from a few miles to a hundred or even two hundred, in order to reach a market. Such long lines of wire, experience has shown, are more or less subject to accidents, and consequent interruption of the service. So well is this understood that it is becoming a very generally accepted principle that an auxiliary steam plant for emergency service is a necessary part of any successful hydro-electric installation relying on long-distance transmission. That is to say, besides the cost of the water-power development, the long-distance transmission line and the sub-stations for distributing the electric current in the city where it is marketed, steam-power stations must be built in the city supplied and these stations must be ready at all times for an emergency. Such steam stations are generally made use of also to help the water-power plant carry the peak of the load. It must be understood that the cost of operating steam stations on such service is exceedingly high for the power developed. The capacity of such a station must be equal to the maximum demand, or else some of the customers must be cut off when any accident cuts off the supply from the water-power plant.

"We believe these difficulties ought to be more clearly understood by investors and by the general public. Because of ignorance as to these matters, engineers engaged in water-power development are often unjustly blamed for the financial failure of an enterprise; or if they make a success, they fail to receive the credit which should be given them. It ought to be apparent also that good engineering is a prime necessity if success is to be attained in any water-power enterprise. It takes an engineer of ability and experience to determine beforehand whether a water-power project can be made a profitable enterprise. It takes an equally good engineer to so carry out the work that profits may be secured."

THE EXAMINATION OF WATER BY ELECTRICAL METHODS.

THE VALUE OF CONDUCTIVITY TESTS IN CHECKING THE OPERATION OF STEAM PLANTS, AND A NEW TYPE OF APPARATUS.

W. Pollard Digby—Institution of Electrical Engineers.

THE well known physical fact that the electrical conductivity of distilled water is greatly increased by the addition of even minute traces of impurities is the basis of a simple device for testing water for boiler-feed purposes which recently made its appearance in England. One of the inventors, W. Pollard Digby, has described its construction and uses in a communication to the Institution of Electrical Engineers, which is abstracted in *The Electrician* for July 29. Mr. Digby does not suggest that the measurement of conductivity alone will supersede chemical analysis in water testing; that the electrical method has important supplementary uses, however, is amply evident from an examination of the results quoted in his paper. We are unable to reproduce these results in our review, but we give Mr. Digby's description of the apparatus used in the conductivity test and a few details of its applications.

"That water in its varying degrees of impurity is anything but a medium of constant value comes within the experience of all engineers, and hence frequent resort is made by the engineer to the analytical chemist for advice and assistance. However, this is not always done as often as might be desired, and a variation in the nature of a supply may take place with no visible change in the appearance of the water, but yet with such changes in the constituents as would render the water quite unsuitable for boiler-feed purposes. The author's object is to point out the value of simple tests made *in situ* as safeguarding the owners of boilers from such happenings, and as determining when the analytical chemist should be employed. These tests, however, are not intended in any degree to supersede the analyst, but may serve to determine when detailed analyses are necessary by indicating changes in the impurities in the water. The method resolves itself into a determination of the conductivity of the liquid at any predetermined temperature and a comparison of such determinations with the known values of analysed samples. Any marked variation from the normal should be followed by a further analytical examination.

"An apparatus for conductivity measurements has been devised by Mr. C. W. V. Biggs and the author. The original type consists of a straight glass tube so constructed as to hold the equivalent of a body of liquid 10 centimetres in length and 1 square centimetre in sectional area, the liquid being contained between platinum electrodes attached to plugs of ebonite fixed in cups which form enlargements of the ends of the tube. The electrodes are suitably connected to terminals in the ebonite ends, and are capable of being adjusted. The liquid to be tested is introduced into the main tube through a small tubulure, rising at an angle from the middle of the upper part; and when tested is run off through a small tube furnished with a tap attached to the middle of the lower part. At each end of the upper surface of the body tube a vent tube is attached, inclining to the middle of the main tube, and the two unite at a height of about 2½ centimetres above it, with a short vertical outlet.

"Manifestly such a piece of apparatus is hardly suitable for use outside the laboratory. The form for practical work consists of a glass U tube, to which is attached at the lowest point of the bend the tube brought from the filling funnel, whilst the outlet, controlled by a glass tap, is joined to the inlet at its lowest point. Near the extremities of the limbs of the main tube overflow ways are sealed on, and terminate in india-rubber tubes grouped with the lower outlet. The form and arrangement of the electrodes are especially designed to minimise the disturbing effects of polarisation and other difficulties inseparable from the original type of tube. The electrodes are open cylinders of platinum, about 9 millimetres in diameter and 3 millimetres in height, connected by three equidistant platinum wires to stout brass glass-covered rods passing through the brass covers which are connected to the terminals. The dimensions of tube and electrodes are such that the equivalent of a body of liquid having a length of 10 centimetres and a sectional area of 1 square centimetre is obtained. The apparatus is mounted on a strong wooden support carrying a thermometer, and the whole is contained in a lock-up portable case.

"The most convenient instrument for measuring the conductance is the 'conductance meter' made for use with the tube. It resembles the familiar 'megger,' but is furnished with a scale graduated in reciprocal megohms and ohms, and with a tube of sectional area one-tenth the length it gives readings of one-tenth of the specific conductivity—equivalent to the reciprocal of 10 times the specific resistance. Correction for variation of temperature for water containing less than 1 per cent. of dissolved salts may be made with sufficient accuracy by taking the coefficient as 2.19 per cent. per 1 degree C., as referred to 20 degrees C.; but above 38 degrees C. such correction is not reliable owing to complications arising from disengagement of small quantities of dissolved gases and also from physico-chemical action.

"At the outset the author experienced considerable difficulty in determining standards for comparison. Of samples passing through the author's hands, good distilled water has varied in its specific conductivity from 4.0 to 1.362 reciprocal megohms for laboratory distilled water, and for distilled water from surface condensers the best has been 3.3 reciprocal megohms. As a general standard of comparison, good distilled water might possibly be defined as possessing a specific conductivity of 3.3 reciprocal megohms, or a specific resistance of 300,000 ohms at about 20 degrees C., this value representing an approximate average value of the output of the Liebig condensers in the laboratory of one of the author's friends, and also representing the best practice from central-station surface condensers that has come under the author's notice."

The effect of minute traces of impurities in greatly increasing the conductivity of distilled water is a well known physical phenomenon. Mr. Digby gives a number of typical results of his investigations of the effect of minute traces of sodium chloride, sodium carbonate and calcium sulphate. The difficulty with the electrical test, of course, lies in the fact that it cannot distinguish between the different impurities. Nevertheless, conductivity tests are of value in detecting variations in the quality of feed water, and in checking the operation of marine evaporators and of evaporators for the supply of distilled water for hydraulic gun mountings. One of their most practical applications is in checking the operation of surface condensers. Given a boiler free from priming, a single conductivity measurement of the water passing from the condenser to the hot well will indicate the tightness of the condenser tubes. If the approximate rate of flow is known at any moment, together with the value of the circulating water, a reference to standard curves, examples of which are given by Mr. Digby, will give the percentage of leakage at that moment. Conductivity determinations, while indicating that overhauling is necessary, may save unnecessary examinations. Conductivity tests may also be used to indicate boiler priming. If the conductivity of the hotwell water rises as the load on the engine increases, the only possible deduction is that the boiler is priming. Mr. Digby gives the results of a number of tests of boiler plants, which serve to demonstrate the procedure and the utility of electrical tests for this purpose.

"So far as checking the operation of steam plants by conductivity methods is concerned, their application does not cease with checking the nature of the feed water or with ascertaining condenser tightness, or even with defining boiler priming. A film of oil is more to be dreaded than scale-forming impurities in the management of boilers. An oil eliminator in one form or another is a necessary adjunct in all electricity-supply stations containing reciprocating sets, but their careless operation in a manner other than that designed by the makers may involve the substitution of a less evil for a greater one. The author has good reason to believe that in certain cases an excess of chemicals is added beyond that required for the elimination of the oil. This in cumulative small doses can only result in the increasing impurity of the boiler water through its enrichment with a substance which by common consent is regarded as a source of priming.

"A last point may be mentioned. Where hard waters containing an excessive quantity of calcium and magnesium carbonates are softened by the Clark process, the conductivity tube and conductance meter can be used as a substitute for the standard soap test in defining how far the process of softening has been carried."

WATER REQUIREMENTS OF SURFACE CONDENSERS.

AN ANALYSIS OF THE EFFECT OF THE OUTLET TEMPERATURE OF THE CIRCULATING WATER ON THE QUANTITY OF WATER REQUIRED.

R. M. Neilson—The Engineer.

REDUCTION of the quantity of circulating water required to condense a given amount of steam is one of the most important results of recent progress in surface-condenser practice. Broadly speaking, the reduction of circulating water to a minimum is desirable, but there are economic limitations to the degree to which it may profitably be carried. The quantity of water which is satisfactory in one case may be very unsatisfactory in another, even if the vacuum, the inlet temperature of the circulating water, and the steam to be condensed are the same in both cases. The saving resulting from the reduction of the quantity of condensing water may not compensate for the cost of the increased cooling surface required.

The quantity of water to be employed should be determined before the condenser is designed, so that a suitable velocity through the tubes may be chosen. In *The Engineer* for June 17, R. M. Neilson demonstrates the dependence of the most economical quantity of circulating water for any given case, on the best value for the difference between the temperature of saturated steam corresponding to the vacuum in the condenser, and the temperature of the outlet water. He shows clearly the great variation of the latter value in different cases and gives an analysis of the method of determination, which is reproduced in brief below.

To determine the quantity of circulating water, the inlet and outlet temperatures of the water and the quantity of steam to be condensed in a given time must be known or assumed. The determination of the outlet temperature is most important, since the outlet temperature affects not only the quantity of water required but also the amount of cooling surface. The calculation of the circulating water, based on the data mentioned and on the fact that the heat absorbed by the water equals the heat lost by the steam, is very simple.

Let t_i and t_o be, respectively, the inlet and outlet temperatures of the circulating water in degrees F.; *W*, the weight of steam to be condensed per hour in pounds; *L*, the latent heat of steam in B. th. u. per pound; *Q*, the weight of water circulating per hour in pounds; θm, the mean difference in temperature between steam and circulating water in the condenser in degrees F.; *S*, the area of cooling surface in square feet; *K*, the amount of steam, in pounds, which can be condensed per square foot of cooling surface per hour per degree F. difference in temperature between steam and water—a value depending on the pressure of the steam, the amount of air, the velocity of the circulating water, the cleanness and diameter of the tubes, and the general design of the condenser; t_v, the temperature of saturated steam corresponding to the vacuum; δ, the difference between t_v and t_o; and *v*, the velocity of the circulating water in feet per second.

If all the steam admitted were condensed and the water of condensation withdrawn at the boiling point corresponding to the condenser vacuum, we should have

$$Q = \frac{WL}{t_o - t_i}$$

In practice, however, these ideal conditions are never realized and this equation cannot be expected to give exact results. It is, in fact, useless to hope to get exact results by calculation. It is usually desirable in condenser design to allow rather for an excess than for a scarcity of circulating water, and a convenient equation for the determination of *Q* is

$$Q = \frac{1{,}000\ W}{t_o - t_i}$$

in which *W* is not the steam alone but the steam plus water admitted to the condenser in the steam.

The transmission of heat from the steam to the water is approximately proportional to the mean difference in temperature (θm) between the steam and the water. The exact determination of θm involves taking into account the air, which, at the air-pump suction end of the condenser, represents a considerable proportion of the air-steam mixure. A simple and convenient formula is

$$\theta m = t_v - \frac{t_o + t_i}{2} - C$$

where *C* is a constant depending on the design of the condenser, the capacity of the air pump, and the air richness of the steam entering the condenser, usually having a value between 1 and 5. θm having been determined, *S* can be obtained from the equation

$$S = \frac{W}{K\theta m}$$

An examination of the formulæ given above will show how the value of δ affects *S* and *Q*. A low value of δ imposes a relatively small quantity of condensing water but a relatively large area of cooling surface; a high value of δ, a small area of cooling surface but a large quantity of condensing water. Any value of δ from zero up to the difference between t_i and t_v may be chosen and the temperature obtained under any given conditions by providing a condenser of suitable design, with sufficient cooling surface and circulating water. In general, if δ is to have a value near its possible maximum, the condenser tubes must be of large diameter in proportion to their length, and the water must pass through them only once; if, on the other hand, δ is to have a value approaching zero, the tubes must be long in proportion to their diameter or the water must make many passes through them, and a counter-current action is necessary.

The determination of the best value of δ for any case involves a comparison of the cost of the condenser cooling surface with the cost of the pump and the motor that drives it, the cost of the steam or electric energy required by the pump motor, and the cost of the condenser water or the cost of cooling it for repeated use. The plant load factor, of course, must always be considered. The velocity of the circulating water has some influence on the best value of δ, but within the limits usually adopted its effect is not of very great importance. The most important factor is the height to which the condensing water has to be pumped before admission to, or after discharge from, the condenser, and the frictional or other losses external to the condenser which affect the head against which the circulating pump has to act. If the total head external to the condenser is great, it will be advisable to reduce to a minimum the quantity of circulating water, even if this reduction involves considerable increase in the cost of the condensing plant. If, on the other hand, the external head is very small, and if the charge for water amounts to little or nothing, δ should be given a high value in order to reduce *S*.

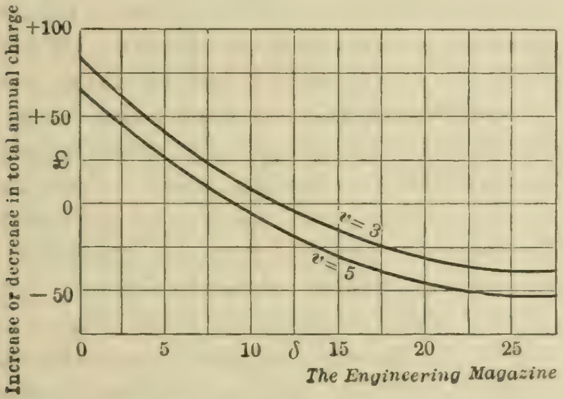


FIG. I. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 10 PER CENT. AND NO EXTERNAL HEAD.

Figures 1 and 2 show the best values for δ when the water has to be pumped through the condenser but not against any outside head. This case occurs when the source of the condensing water is so located that a statical head is obtained, either on the admission or on the discharge side of the condenser, sufficiently large to overcome the friction in the admission and discharge pipes, but not the friction within the condenser. The diagrams have been prepared for cases in which the pressure of steam within the condenser is 1.5 pounds absolute—the corresponding temperature being 116 degrees F.—and the circulating water enters the condenser at a temperature of 82 degrees F. The capacity of the plant is 56,000 pounds of steam per hour. The frictional head within the condenser varies with the velocity of the circulating water; the pump power varies with the head and with *Q*, the latter varying with δ.

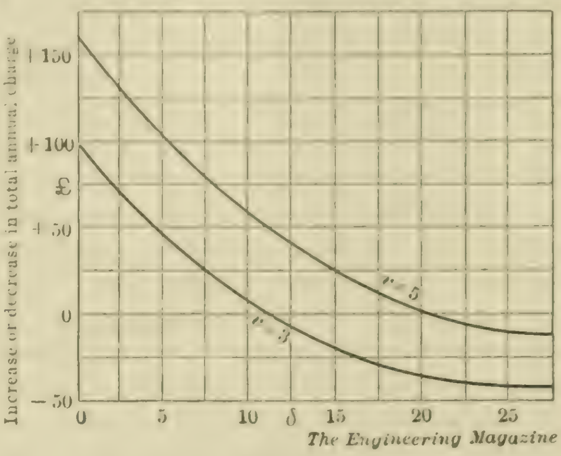
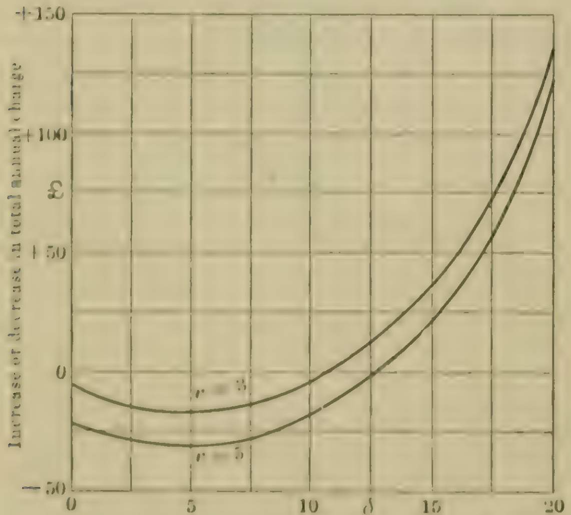


FIG. 2. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 33 1/3 PER CENT. AND NO EXTERNAL HEAD.

The ordinates in the figures represent the annual charge, taking into account, not only the cost of pumping, but also the costs of interest, repairs, depreciation, taxes, etc., which are taken at 15 per cent. of the initial cost of the plant. Instead, however, of expressing the total annual charge, the ordinates express only the difference between the total value of δ and the total charge when δ = 11 and $v = 3$, these conditions being taken as standard for the sake of comparison. The cost of pumping has been taken at ¾d. per hydraulic horse power hour. Two values of v have been taken, 3 feet and 5 feet per second. No velocity far removed from these figures is used in practice. Curves for slightly lower or slightly higher velocities than 3 and 5 feet per second or for intermediate velocities are of the same general nature as the curves shown.

It will be seen that the best value for δ is at the extreme right of the curves. In Figure 1 a low plant load factor (10 per cent.) has been taken; a much higher load factor (33 1/3 per cent.) has been assumed for Figure 2. The plant but has little effect on the value of δ. which lies in all cases between 25 and 30 degrees. In Figure 1 the curve showing a velocity of 5 feet per second is lower than the other; in Figure 2 the positions are reversed.

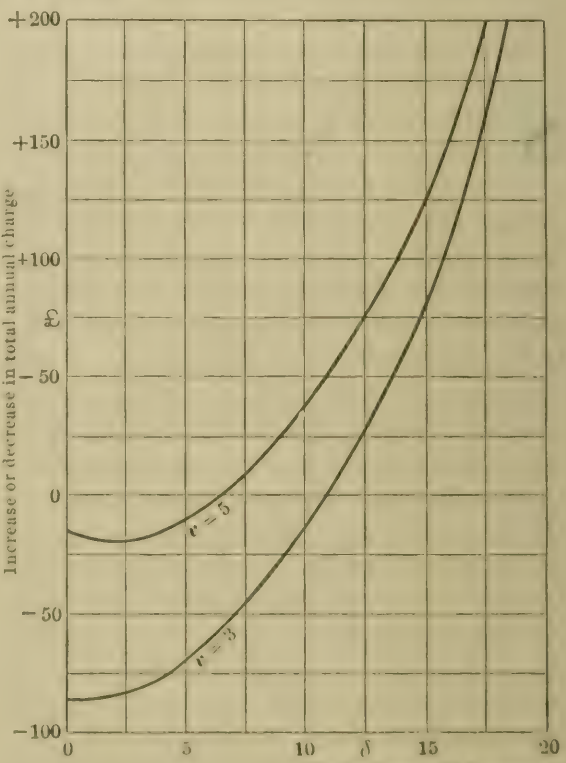
The curves in Figures 3 and 4 are calculated from the same vacuum and inlet temperatures of circulating water as those in Figures 1 and 2, but in these cases the use of cooling towers is assumed and the initial cost of the towers and the cost of pumping water through them is taken into account. It is usual with natural-draft cooling towers to lift the water about 25 feet above the level of the pond below the tower; allowing for pipe friction, etc., the external head against which the condensing water has to be pumped is taken at 35 feet. The curves prepared to suit these conditions are very different from those in Figures 1 and 2. The best value of δ, instead of being between 25 and 30 degrees, is between 0 and 5 degrees. The great cost of pumping the water through the tower and the cost of the tower itself, both dependent on the quantity of water dealt with, make it desirable to reduce the circulation of water, even at the expense of increasing the cooling surface of the condenser.



The Engineering Magazine

FIG. 3. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 10 PER CENT. AND AN EXTERNAL HEAD OF 35 FEET.

The conditions assumed for Figures 1 and 2 represent one extreme; those for Figures 3 and 4 very nearly the other extreme. When the conditions are between those assumed for the two sets of curves, the best value for δ will, of course, occupy an intermediate position. While these curves have been prepared for a pressure in the condenser of 1.5 pounds absolute, they would apply fairly well to cases in which the inlet temperature of the condensing water was higher or lower than 82 degrees F., if the steam pressure in the condenser were so altered that the steam temperature was correspondingly raised or lowered. The cost of the condenser, however, rises slightly with increase in vacuum, but a vacuum much above 27 inches is hardly ever desirable with cooling towers.



The Engineering Magazine

FIG. 4. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 33 1/3 PER CENT. AND AN EXTERNAL HEAD OF 35 FEET.

The cost of hydraulic horse power has the same effect upon the best value for δ as the plant load factor. For example, there is the same difference between 0.5d. and 1.6d. per hydraulic horse power hour as between 10 per cent. and 33 1/3 per cent. plant load factor.

"It is evident from an inspection of the figures that one design of surface condenser cannot be best under all conditions. For use with cooling towers, or in any case where the external head is great, a design of condenser should be employed in which the length of the tube elements is great in proportion to the diameter of the tubes, so that δ has a low value, and a relatively small quantity of water suffices. When, on the other hand, the external head is small, the length of the tube element should be less for the same tube diameter, so that δ is much increased, and the cooling surface of the condenser can be very considerably reduced. The conditions under which condensers on land work vary greatly. With marine condensing plant the conditions do not vary quite so much, but even here the external head varies. Moreover, the vacuum depends on whether piston or turbine engines are employed; and t, depends on the latitude, etc., and on the season."

ILLUMINATION REQUIREMENTS IN STREET LIGHTING.

AN ANALYSIS OF THE PROBLEM OF SECURING UNIFORMITY OF ILLUMINATION WITH ELIMINATION OF GLARE.

Arthur J. Sweet—The Franklin Institute.

SOME plain criticism of American practice in street lighting, addressed to the American Society for Municipal Improvements by Dr. Louis Bell, was printed in these columns of THE ENGINEERING MAGAZINE for March last. Dr. Bell's chief complaint is against the lack of careful discrimination in the adjustment of illumination to the needs of various classes of streets, but he finds much to criticise also in the methods of light distribution and measurement. In short, streets are lighted but not illuminated. In a paper before the Franklin Institute, printed in the *Journal* for May, Arthur J. Sweet predicts a change in this condition. We are standing to-day, he says, in the dawn of a new epoch—the epoch of street illumination as contrasted with street lighting. He analyzes the problem of securing uniformity in street illumination and of eliminating glare effects in an extremely lucid and comprehensive manner.

The problem of illumination involves three factors—a quantity factor, a quality factor, and a physiological factor. Intensity and distribution (relative intensity) linked together form the quantity factor. The independent elements diffusion and color value are combined in the quality factor. Total light flux in the field of vision and shadow contrasts are two closely related yet separate factors affecting the efficiency of the eye, the physiological factor. Subordinate to the factor of total light flux in the field of vision is the intrinsic brilliancy of light-giving or light-reflecting objects in the field of vision.

Two results are to be achieved in adequate street lighting—the avoidance of glare effect and the obtaining of an approximately uniform degree of illumination at all points along the course of the street, with higher intensities at street corners. These two results can only be obtained, the one by the correct solution of the allied problems of intrinsic brilliancy, total light flux, and shadow contrasts, the other by the correct solution of the problem of distribution.

Glare effect results whenever an amount of light falls upon the actually visualizing portion of the retina of the eye sufficient in quantity to cause chemical changes more rapidly than the regenerative functions of the eye can keep pace with. For convenience, a glare condition may be designated as casual, when it results from the inability of the pupil to adjust itself instantly to a changed condition of light intensity, and as fundamental, when it results from a light intensity exceeding the contractive power of the pupil to compensate for, or when it results from a light source near the centre of the field of vision. The presence of strong shadow contrasts tends to produce a casual condition of glare. The avoidance of objectionably located shadow contrasts can be taken care of only by the proper placement of light sources, while the intensity of the shadow contrast can be decreased by using smaller light sources placed nearer together. The problem is one which must be solved independently for each individual case. A fundamental condition of glare, with resultant heavy decrease in efficiency of vision, is produced by brilliant, high candle-power light sources in the field of vision, the usual practice in contemporary street lighting. It can be avoided only by the proper limitation of the intrinsic brilliancy and total light flux of the light units employed. The study of the relations existing between intrinsic brilliancy and total light flux on the one hand, and glare effect on the other, becomes, therefore, one of an analysis of the illumination requirements.

The ideal to be aimed at in street lighting is uniform illumination of all points along the course of the street, with the exception of street intersections and similar crossings. The present almost universal condition of brighter illumination under and near the light unit is simply a concession to ignorance of how to obtain something better. The illumination at street intersections should be from four to eight times the intensity along the main course of the street; this, however, is merely a matter of installation. It is true within limits that in other parts of the street absolute uniformity of illumination is not required, but there is no scientific justification for a ratio of maximum to minimum intensity greater than four to one. The ratio in American practice is most frequently over 100 to one. As Dr. Bell has pointed out, the method of measuring illumination in the plane normal to the ray is responsible for a great deal of the poor light distribution in American streets. Mr. Sweet agrees with him that the measurements should always be in the horizontal plane.

Once ideal curves of light distribution to give uniform horizontal illumination are derived, the fact that absolute uniformity is not of importance, provided the ratio between maximum and minimum intensity is not greater than four to one, may be taken into account. The selection of the most desirable distribution from the infinite number which will give uniform illumination from a line of light units along a line immediately under these units will depend upon two considerations—first, that the distribution must be practicable of attainment, and, second, that the illumination at any point should be derived from a source as near as possible in order to avoid both excessively long shadows, and the glare effect which results from the high candle power necessary for illumination at great distances. Mr. Sweet discusses a number of illumination curves illustrated in his paper. The illumination curve which best meets the conditions imposed is formed by two circle quadrants. The corresponding distribution curve shows a low maximum which occurs at a slightly smaller angle than that subtended by half the separation of the units. The desired distribution curve can be easily derived from the ideal illumination curve.

The relation between any desired illumination results and the distribution required to produce these results depends upon the distance between adjacent units and the height of the light unit above the street; that is to say, for any given separation of units and height above street, we can easily calculate the distribution curve which will produce the desired illumination result. It is obvious that any given distribution curve will give the same proportionate illumination results so long as the relation between the separation of units and the height above street is kept constant, since so long as this relation remains constant, the angular relations are unchanged. Hence, for any value of the ratio between separation of units to height above street, which Mr. Sweet calls M, there is a certain distribution curve which will produce the required illumination result. In American practice the most representative value of M is 15. Mr. Sweet gives a number of polar curves of light distribution, for different values of M, intended to give uniform results. He shows that, when the light sources are separated by a distance greater than six times the mounting height above the street (that is, when M is greater than 6), it becomes impracticable to design a unit giving such light distribution as would be required for a sufficiently close approximation to uniform illumination.

Returning now to glare effect, it remains to determine the laws of operation of the conditions which produce it, and the limitations it imposes on the solution of the illumination problem. The consideration of the avoidance of glare effect will operate by imposing a definite candle-power limit at each distribution angle, this limit varying only with the mounting height. In proportion as this candle-power limit is exceeded a greater or less glare effect will result. The net result of the limitations imposed by the avoidance of glare will be to eliminate for any given mounting height all curves of ideal distribution exceeding some definite value of *M*.

Glare effect may be assumed to vary with the following factors: (*a*) distance of the eye from the light source; (*b*) total light flux in the direction of the eye, measured in apparent candle power at the distance of the eye; (*c*) intrinsic brilliancy of the light source; (*d*) angular position of the light source in the field of vision, the visualized object being assumed to occupy the centre of the field of vision; and (*e*) distance of the light source from the eye relative to the distance of the visualized object upon which the eye is focused. Mr. Sweet has devised a method of measuring glare effect, the measure being the ratio of the two minimum light intensities on a visualized object, of magnitude just sufficient to enable its discernment, when the eye is successively exposed to the two conditions under comparison. He has made an extended research on the five factors mentioned above, which he describes in detail. We have space here merely to summarize the results, and the conclusions Mr. Sweet draws from them. At any given candle power, a considerable increase of distance produces only a small decrease in glare effect. For all ordinary distances, the presence of a light source of even a very low candle power in the field of vision causes a tremendous drop in visual efficiency. At 300 candle power, however, the glare effect has nearly reached its maximum, and beyond 300 candle power a large increase in candle power produces but a small decrease in visual efficiency. An investigation of the relation between glare effect and the angular position of the light source in the field of vision disclosed a fact of the highest importance—that at an angle varying, depending on the candle power, between approximately 22 degress and approximately 26 degrees, the glare effect reaches zero, although the light source is still well within the field of vision. This means that the light instrumental in causing glare comes entirely from the polar angles above 60 degrees. In the average actual case, glare is almost wholly caused by the light between the angles of 65 degrees and 80 degrees with the nadir. The light within these angles must be partially or wholly suppressed if glare is to be avoided.

Mr. Sweet gives a series of curves of zero glare effect for various mounting heights, with which he compares the curve of ideal distribution when *M* equals 6. It is at once apparent that this curve, together with curves of larger values of *M*, will be eliminated, on account of the serious glare effect which would result from the application of such distributions to actual practice. The curve *M* equals 4, however, comes within the limitations imposed by the curve of zero glare effect, providing the scale of the *M* equals 4 curve does not exceed that amount which would make the zero-degree candle power equal 100. The distribution curve corresponding to *M* equals 3 would come well within the limitations imposed by zero glare. For all practical purposes, 60 degrees is an absolute limit for maximum candle power if serious glare effect is to be avoided.

"In designing a light unit to give the desired distribution which has largest field of application, namely the distribution from *M* equals 4, it will be preferable by far that the candle-power values at 60 degrees and above be less than those made proper by the ideal curve, rather than that these ideal values be exceeded. With an ideal curve of such candle-power magnitude as would be most useful, the candle-power values at the angles under consideration come perilously near to the glare limit, or may even exceed the glare limit. A per cent. variation from the ideal curve of four to one is, as has been pointed out, permissible. Even a moderate condition of glare, on the other hand, is very undesirable. Practical considerations, therefore, will lead us, in the design of the actual unit, intentionally to deviate from the *M* equals 4 curve at the angles of 60 degrees and above, this deviation being in the direction of lesser candle-power values."

WASTE GASES AS FUEL FOR OPEN-HEARTH FURNACES.

THE USE OF DIFFERENT GASES FOR OPERATING OPEN-HEARTH FURNACES AND THEIR INFLUENCE ON THE QUALITY OF THE PRODUCTS.

H. Terpitz—International Mining Congress.

RECENT experiments in Germany seem likely to lead to the development of a new field for the utilization of coke-oven and blast-furnace gases. The introduction of the gas engine in steel works has released a large proportion of the waste gases which under steam operation were all required for boiler firing. The excess gases have been used with success in a number of cases for the generation of electric power for sale. It is now established, however, that they can be utilized within the works for the firing of open-hearth furnaces. The results of the German experiments were communicated to the recent International Mining Congress at Düsseldorf by H. Terpitz. The following brief summary is taken from a report in the *Iron Age* for July 14.

Special interest attaches at the present time to the utilization for operating open-hearth furnaces of the waste gases from coke ovens and of the surplus gases from blast furnaces, larger quantities of which become available as the result of the development of gas engines. For instance, 7 to 8 cubic metres of furnace gas is required per horsepower hour for a steam engine, as compared with 3 to 3½ cubic metres of furnace gas for a gas engine. At some works, as the Horde, furnace gas has been conducted in a 3-kilometre pipe line to a distant rolling mill for firing boilers, but other works have no such outlet and must use considerable quantities of gas. At a number of places the effort has been made to take the waste blast-furnace gas to open-hearth furnaces, but the results have been disappointing on account of the low calorific value as compared with good producer gas. The most extensive experiments of the character have been carried out at the new steel works of the Georgs Marienhütte at Osnabrück, where furnace gas alone is used for the tilting primary open-hearth furnaces. Terpitz gives it as his personal opinion that in a few years open-hearth furnaces will be operated successfully, using blast-furnace gas wholly or partly. He supports the proposals of Jos. von Ehrenwerth and Schmidhammer to regenerate blast-furnace gas by passing it through coke breeze or fine coal heated with oxygen manufactured by the Linde process.

As for the utilization of waste coke-oven gas for working open-hearth furnaces, the Hubertushütte started to do this in May, 1907. During the first calendar year the normal coal consumption was brought down by only 2.13 per cent. In 1908, however, 41.19 per cent. and in 1909, 43 per cent. of the total coal consumption was supplanted by coke-oven gas. The best results were obtained in September, 1909, when, on a production of 6,200 tons of ingots, the coal consumption amounted to only 14.9 per cent., so that 53.15 per cent. of the total requirements of coal were supplanted by coke gas. In these comparisons the basis was the average annual coal consumption of 1906, when it amounted to 318 kilogrammes per ton of ingots.

The new coke plant consists of two groups of 45 Otto-Hoffman ovens each, in which 320 tons are put through in 24 hours. The excess of gas per day is 60,000 to 70,000 cubic metres, which is not alone used for the open-hearth furnaces but also for heating the drying ovens of the foundry and for other purposes. It carries 6.5 per cent. carbonic acid, 2 per cent. of heavy hydrocarbons, 1 per cent. of oxygen, 16.4 per cent. of methane, 38.7 per cent. of hydrogen, 24.8 per cent. of nitrogen and 10.6 per cent. of carbonic oxide. The lower calorific value is about 3,300 heat units without elimination of benzol.

Terpitz ascribes the adverse effect upon the quality of the steel, which is usually attributed to the presence of hydrogen in the heating gases, entirely to mistakes in the temperature of the open-hearth heats, which may easily be made worse by mistakes in casting. He takes similar ground as to nitrogen. As for sulphur in the heating gas, he cites some experiences and urges that the prejudices against the effect of heating gases upon the metal in the basic open-hearth process be dropped, and that attention be directed wholly to the gases which are generated in the bath itself in the oxidizing and reducing reactions. He admits a lowering in the life of furnace ports and roofs by 8 to 10 per cent., which he attributes to the increased difficulties which the employment of a higher-grade gas involves.

Since it has been shown that open-hearth furnaces may be operated with full success with waste coke-oven gas, a wide range is opened for the by-products of coke-oven plants. Since it is easier to utilize low-grade dust coal under boilers than in the producers of open-hearth furnaces, it may prove expedient in some localities to deliver the coke-oven gases rather to the open-hearth furnaces than to the boilers, and the question may arise, where gas engines are in use, whether the excess of waste coke-oven gas be more effectively used for generating power or for heating open-hearth furnaces. If there be an excess of both waste blast-furnace gas and of coke-oven gas, it will be best to utilize the coke gas for the open-hearth furnaces and the blast-furnace gas for the engines, because the higher calorific value of the former is useful for the working of the furnaces but is rather disadvantageous for driving gas engines because of the greater strains put upon the working cylinders and valve heads of the gas engines as the result of the higher temperatures. An intimate and regular mixture of gas and air is more easily attained in using blast-furnace gas for the engines, because the volumes are more nearly alike than they are with coke-oven gas with its three and one-half times higher calorific value.

THE COST OF DRIVING STEEL-WORKS BLOWING ENGINES.

A COMPARISON OF THE COST OF DRIVING BLOWING ENGINES BY STEAM ENGINES, GAS ENGINES AND ELECTRIC MOTORS.

Otto Mauritz—International Mining Congress.

THE use of gas-engine driven blowers in steel works has not kept pace with their introduction in blast-furnace plants. Blast-furnace blowing engines work under a uniform load. In steel-works operation, however, intermittent working, variations in the blast pressure and other conditions are not so well suited to the gas engine, and, notwithstanding their economy, gas-driven blowers have been introduced in comparatively few plants. There seems to be little question, however, of the superior economy of gas power for this purpose in comparison with both steam and electric power. Otto Mauritz shows, in a paper read at the recent International Mining Congress at Düsseldorf, that the difference in cost is very considerable, particularly when coal is high-priced. A brief abstract of his comparison of the costs of the three modes of driving is taken from a report in the *Iron Age* for July 14.

Until now the piston steam engine has been generally used for driving steel-works blowing engines. For new works there should be taken into consideration the use of a steam turbo-blower, while at old works even in the purchase of a blowing engine a turbo-blower would not be entertained, because it cannot compete in cost with the piston engine, usually only low superheat being available. The peculiarities of steel-works practice, frequently interrupted working and wide fluctuations in volume and pressure of blast when compared with blast-furnace blowing engines seem apparently to tell against the employment of gas engines. This accounts for the fact that so few German works have selected gas engines for driving steel-works blowing engines, although the advantage in low cost of operation is very great. A gas blowing engine is naturally operated in a different manner from a steam blowing engine. The former is not stopped during the pauses in blowing, but it is allowed to run at reduced speed, which involves some consumption of fuel—a loss, however, which is not larger than the loss by condensation in the pipe line of steam blowing engines during these pauses.

Herr Mauritz takes as the basis of his comparisons a steel plant with an annual production of 400,000 tons of ingots. The annual cost of running a 4,000-horse-power blowing engine is:

1. Sinking fund and interest:
   Engine and foundations.......12 per cent.
   Building ....6 per cent.
2. Water consumption per ton of steel ingots:
   Steam blowing engine ....7.3 cubic metres = 258 cu. ft.
   Gas-driven engine ....2.4 cubic metres = 85 cu. ft.
   Electrically driven engine ....0.125 cubic metres = 4 cu. ft.
   1 cubic metre is reckoned to cost 1 pf. (3d. per 1,000 cubic feet).
3. Wages, lubricant, material for cleaning and maintenance, repairs, per ton of steel ingots:
   Steam blowing engine, coal-fired boilers.......0.139 m. = 1.4d.
   Steam blowing engine, gas-fired boilers.......0.088 m. = 0.9d.
   Gas-driven blast engine.......0.88 m. = 0.9d.
   Electrically driven ....0.015 m. = 0.1d.*
4. Cost of fuel or of electric current.

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* This figure does not take into account the electric generating set; the cost for this is included in that for the current.

With a view to comparison on a common basis, the fuel costs are reckoned within the following limits: coal (7.5 evaporative power), 10 to 20 marks (10s. to 20s.) per ton; blast-furnace gas, 900 calories (101 B. t. u.), 0.90 to 1.80 marks (9d. to 15.8d.) per 1,000 cubic metres (35.320 cubic feet).

In valuing the blast-furnace gas, the volume of this gas taken was that equal to the weight of coal required to generate the same volume of steam. An efficiency of 75 per cent. was reckoned upon in the case of the coal-fired boilers, and an efficiency of 53 per cent. in that of the gas fired boilers. The cost of the steam remains, therefore, the same in both cases, whether using as boiler fuel coal of 7.5 evaporative power at 10 marks per ton, or blast-furnace gas of 900 calories, at 0.90 mark per 5000 cubic metres.

The cost for electric power is more difficult to state than that for coal or blast-furnace gas; in the case of current it would be necessary to consider both whether it be produced by a steam-turbine plant (boilers either coal- or gas-fired) or in a gas-driven generating station. With a view to deal fairly also with this point, the diagrams given by Herr Mauritz apply to a current cost varying from 1.5 pf. to 3 pf. (0.15 to 0.3d.) per kilowatt-hour. This is not to be taken to imply that where coal costs 10 marks per ton, the kilowatt-hour should be valued at 1.5 pf.

The higher and the lower limits of running cost are as follows:

Type of blowing engine.	Cost: 1 ton coal at 10 m., or 1,000 cu. m. gas at 0.9 m., or 1 kw.-h. at 1.5 pf. Marks.	£	Cost: 1 ton coal at 20 m., or 1,000 cu. m. gas at 1.8 m., or 1 kw.-h. at 3 pf. Marks.	£
Steam, coal fired boilers	268,800 =	13,440	401,000 =	20,050
Steam, gas-fired boilers	255,800 =	12,790	388,000 =	19,400
Gas-driven blowing engines	156,500 =	7,825	206,900 =	10,345
Electrically driven reciprocating blowing engines	194,500 =	9,725	344,500 =	17,225

The above comparison which applies to a new plant (case 1) shows the great superiority of gas-engine driving. The paper also considers whether a gas-driven blowing engine would be economical in cases (2) of a metallurgical works owning a steam-driven blowing engine the cost of which has been written off and (3) of a similar works whose steam-driven blowing engine is not yet written off. In the latter case, the annual provisions for sinking fund and for interest have, therefore, to be added to the annual operating cost.

The paper shows that here also the gas-driven blowing engine is the most advantageous, since the annual saving in running cost which it yields, as against a steam-driven blowing engine using gas-fired boilers, is as follows:

In case 1a. 99,300 m. = £4,965	In case a, cheapest fuel cost, 10 marks per ton.	
In case 1b. 181,900 m. = £9,095		
In case 2a. 39,300 m. = £1,965		
In case 2b. 121,900 m. = £6,095	In case b, highest fuel cost, 20 marks per ton.	
In case 3a. 39,300 m. = £1,965		
In case 3b. 121,900 m. = £6,095		

The savings in cases 2 and 3 are equal; the absolute cost figures vary.

Simplicity, accessibility and uniformity of the plant, that is, complete electrification, might finally lead to the putting down of an electrically-driven blowing engine (turbo-compressor), if purely economical conditions be aimed at. The conditions, however, require careful consideration for arriving at a correct solution. And when this is reached there is still to settle the point as to whether the current-generating dynamos are to be driven by gas engines or steam turbines. Under this head the author concludes that a gas-driven power station is by far the more advantageous of the two.

BRIQUETTING IRON AND STEEL CHIPS.

A PROCESS FOR UTILIZING CHIPS DEVELOPED IN GERMANY, AND ITS ECONOMIC RESULTS.

Hubert Hermanns—American Machinist.

CHIPS in many machine shops offer a problem of considerable difficulty. In quantity they often amount to 10 per cent. of the total production of the shop. The most economical method of disposing of this refuse is to use the chips in place of other materials in furnace mixtures, but in utilizing them in this way many practical difficulties are encountered. When loose chips are charged into a furnace, part are driven out by the blast, and part are subjected to violent combustion and pass into the slag as ferric oxide. The loss amounts to as much as 50 per cent., and the large amount of viscid slag formed interferes seriously with the proper operation of the furnace. Outerbridge solved the problem by packing the chips in wooden or cast-iron boxes which he added to the charge, but the cost of this method is prohibitive except for the production of iron which can be sold at a high price. Melting down the chips in the furnace with a low blast has not given satisfactory results, nor have attempts to rust the chips together into large masses in the open air.

Trials have often been made to press the chips into briquettes with the aid of a binder. As a rule the binder has failed in the furnace heat and the briquettes have broken up. Aside from the fact that the binder itself is not an ingredient likely to improve the quality of the iron, this also resulted in a large loss in the weight of the chips by oxidation. A new and more promising process of German origin, however, is described by Hubert Hermanns in the *American Machinist* for July 7. The chips are subjected to very high pressure in a press, which compresses them into solid, compact briquettes without the use of a binder. The briquettes are used in furnace mixtures in place of scrap, with very satisfactory results as to quality of product. They are also used in the production of high-grade cast iron as a substitute for expensive grades of pig.

NUMBER 1.

30 per cent. Koldair iron, $22.80 per ton	$6.84
30 per cent. L. O. C. iron, $22.08 per ton	6.62
40 per cent. cylinder scrap, $16.80 per ton	6.72
Total cost of charge per ton..........	$20.18

NUMBER 2.

30 per cent. Frodair iron, $27.60 per ton	$8.28
20 per cent. Bearcliffe iron, $33.60 per ton	6.72
30 per cent. cylinder scrap, $15.60 per ton	4.68
20 per cent. ordinary scrap, $14.40 per ton	2.88
Total cost of charge per ton..........	$22.56

NUMBER 3.

30 per cent. Kraft I iron, $16.80 per ton	$5.04
20 per cent. briquettes of cast iron, $14.40 per ton	2.88
10 per cent. briquettes of steel, $14.40 per ton	1.44
20 per cent. Kraft III iron, $15.60 per ton	3.12
20 per cent. cylinder scrap, $15.60 per ton	3.12
Total cost of charge per ton..........	$15.60

NUMBER 4.

10 per cent. German foundry I, $16.80 per ton	$1.68
20 per cent. Lubeck 3, $15.60 per ton...	3.12
20 per cent. briquettes of cast iron, $14.40 per ton	2.88
10 per cent. briquettes of steel, $14.40 per ton	1.44
40 per cent. scrap iron, $14.40 per ton..	5.76
Total cost of charge per ton..........	$14.88

Mr. Hermanns gives a number of examples of mixtures in which chip briquettes are used in German machine works. We may quote the practice of the Borsig firm at Tegel. Before briquettes were introduced, the two principal mixtures used for high-grade castings, such as locomotive cylinders, etc., with the prices of the iron at Berlin were as in Numbers 1 and 2 above. By using the chip briquettes, similar results were obtained with the mixtures given in Numbers 3 and 4 above. Comparing the most favorable examples presented in these tables, Number 4 shows a saving of $7.68 per ton of charged material over the mixture in Number 2. Comparing the cheaper mixture without briquettes, Number 1, with the dearer briquette mixture, Number 3, there is still a saving of $4.58 per ton.

Tensile, transverse and impact tests have been made in a large German machine works on castings produced from six briquette mixtures of the following compositions:

No. 5. For machinery purposes. Briquettes, 11 per cent.; iron scrap or foundry scrap, 38 per cent. With the iron scrap omitted, 30 per cent. of briquettes is used.

No. 6. For locomotive cylinders. English and German pig with 12 per cent. briquettes and 16 per cent. cylinder scrap.

No. 7. For locomotive cylinders. German hematite and foundry pig with 18 per cent. cylinder chip briquettes and 24 per cent. cylinder scrap.

No. 8. For locomotive cylinders. German high-manganese pig and foundry pig with 24 per cent. cylinder chip briquettes and 34 per cent. cylinder scrap.

No. 9. For steam cylinders. Special grades of pig with 12 per cent. cast-iron chip briquettes.

No. 10. For compressor covers. Special grades of cast iron with 18 per cent. ordinary briquettes and 8 per cent. wrought iron refuse.

The tensile tests were made on 1-inch bars. The transverse test bars were 1 9/16 inches square; their length between supports was 36 inches. For the impact tests, bars 10 inches long were planed to 1½ inches square. They were laid on two knife edges 6¼ inches apart, and subjected to a blow from a 26½-pound weight, begun with a drop of 13 inches and increased by about 2 inches at each stroke. The increase in strength through the addition of briquettes to mixture No. 5 is shown in Table 1. The strengths of the cast irons produced from the other mixtures are given in Table 2. The results would seem to indicate that considerable increase in the strength of castings is to be obtained by the use of briquettes.

The results of another series of tests reported by Mr. Hermanns show that "the effect of the briquettes in the charge is essentially to increase the tensile and transverse strength by reducing the quantity of carbon. Because of their compact mass, as compared with loose chips, the briquettes are protected from strong oxidation in the upper melting zones and against slagging, and in comparison with pig iron they have a more or less porous structure. Thus part of the graphitic carbon present in the briquette is consumed above the melting zone. An enrichment with carbon may take place during the melting, but this does not suffice to make up completely for the carbon that has been lost, and the results are a considerable lessening of the total carbon contained.

TABLE 1.

Test.	Pounds per square inch. Without briquettes.	With briquettes. 20 per cent.	With briquettes. 30 per cent.
Tensile strength	...25,000 to 28,000	32.200 33,200	41,300 42,400
Transverse strength	...37,500 to 47,000	50,600	53,500
	Height of drop in inches.		
Impact	13 to 16	20	22

TABLE 2.

Number of Mixture.	Tensile. Pounds per square inch.	Transverse. Pounds per square inch.	Impact. Drop in inches.
6	37,500	56,500	27.5
6	35,200	55,400	20.0
7	45,700	77,700	25.5
7	48,500	76,000	39.4
8	48,400	78,500	27.5
8	45,700	67,500	29.5
9	35,200	55,400	20.0
9	37,500	56,500	27.5
10	38,700	66,800	25.5
10	39,100	70,000	27.5

"In steel foundries chip briquettes may serve as a substitute for the low-phosphorus white iron that is largely used. In fact, they can be used economically in any place where steel scrap is used, whether it be in the foundry or the steel mill, as briquettes of steel or wrought-iron chips are a good charging material. . . . Chips from hard rolls, projectiles, etc., may be so mixed with gray-iron chips as to make a uniform charging material. Chips from copper, brass, bronze, white metal, etc., have also been briquetted and a saving effected. This is due to the fact that the cost of pressing the chips into briquettes is much less than the savings that are effected in many other ways, such as in the lesser oxidation of the metal in remelting, the easier methods employed in handling the chips, and the less space required for storage."

THE ENGINEERING INDEX

"THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE."

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

Note—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering...............Page 925
Electrical Engineering......... " 933
Industrial Economy............ " 938
Marine and Naval Engineering. " 940
Mechanical Engineering........Page 941
Mining and Metallurgy........ " 954
Railway Engineering........... " 961
Street and Electric Railways.. " 964

CIVIL ENGINEERING.

BRIDGES.

American.

Notes on Recent American Bridges. Brief descriptions of examples of recent work. 2500 w. Engr, Lond—June 24, 1910. No. 15553 A.

Arches.

The Design of Three-Hinge Arches (Beitrag zur Dimensionierung von Dreigelenkbögen). H. Maier. Mathematical. 1500 w. Deutsche Bau—June 15, 1910. No. 15906 B.

Graphical Solution of the Continuous Arch (Le Calcul graphique de l'Arc continu). Louis Schaffner. A detailed mathematical demonstration of the method. Ills. Serial. 1st part. 4000 w. Génie Civil—June 4, 1910. No. 15734 D.

Graphical Determination of the Abutment Reactions of a Fixed-End Arch with Parabolic Axis, Constant Section and Supports of Equal Height (Graphische Bestimmung der Kämpfer-Reaktionen für einen Gewölbebogen—beiderseits eingespannt—mit parabolischer Achse, konstantem Querschnitte und gleicher Höhenlage der Kämpfer). Mathematical. Ills. 1000 w. Zeitschr d Oest Ing u Arch Ver—June 24, 1910. No. 15929 D.

The Fixed-End Arch with Two Intermediate Hinges (Der beiderseits eingespannte Bogenträger mit zwei Zwischengeleken). Cajetan Holik. An exhaustive mathematical discussion. Ills. Serial. 1st part. 4500 w. Oest Wochenschr f d Oeffent Baudienst—June 25, 1910. No. 15932 D.

Culverts.

Methods and Cost of Constructing Concrete Arch and Cast Iron Pipe Culverts by Day Labor, Illinois and Mississippi Canal. Report of the work. 2000 w. Engng. Con—June 29, 1910. No. 15332.

Erection.

The Erection of the Dumbarton Point Bridge. The erection of the superstructure of a bridge on the So. Pacific across the lower end of San Francisco Bay is illustrated and described. 1200 w. Eng Rec—July 23, 1910. No. 15886.

Perilous Bridge Erection. An illustrated account of methods and risks taken in the erection of the Miles glacier bridge, Alaska. Also Editorial. 2800 w. Eng Rec—July 16, 1910. No. 15634.

Foundations.

Substructure of a Double-Track Railroad Bridge at Peoria. Illustrates and describes a substructure of concrete piers and abutments founded on timber piles driven to rock. 2000 w. Eng Rec—July 23, 1910. No. 15884.

Masonry.

The Two Highest Masonry Bridges in the World. F. Honoré. Illustrations and brief notes on the Constantine bridge in Algeria, and the bridge at Ronda, Spain. 350 w. Sci Am—July 9, 1910. No. 15413.

Piers.

See also Foundations, under BRIDGES.

Quebec.

Quebec Bridge Substructure. Illustrated article dealing with the new substructure, it's difficulties and construction methods. 1200 w. Can Engr—July 14, 1910. No. 15636.

Reconstruction.

Reconstructing a Defective Bridge Under Traffic. Brief illustrated description of methods used in reconstructing the Boves bridge, Northern Railway (France). 600 w. Eng News—June 30, 1910. No. 15399.

See also Bridges, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Reinforced Concrete.

The Seventh Street Bridge, Los Angeles, California. Illustrated description of a reinforced-concrete structure of three 80-ft. spans, and having a total length of 318.24 ft. 2000 w. Eng Rec—July 2, 1910. No. 15387.

Reinforced Concrete Bridge at Los Angeles, California. Edward P. Bailey. Brief illustrated description of a novel tower and flume method of distributing concrete, and other features of the construction. 500 w. Munic Jour & Engr—July 13, 1910. No. 15605.

The Reinforced Concrete Bridge over the Iser at Sojowitz (Die Eisenbetonbrücke über den Iserfluss in Sojowitz). Stan. Spacek. Describes a four-span girder bridge. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—June 11, 1910. No. 15930 D.

Restoration.

Restoration of the Auld Brig O'Ayr. Illustrated description of very interesting work for the preservation of an historical structure in Scotland. 4000 w. Engng—July 15, 1910. No. 15970 A.

Steel.

The Mississippi River Bridge at St. Louis for the Illinois Electric Traction System. Illustrated detailed description of this important engineering structure and its erection. 5500 w. Eng News—July 28, 1910. No. 16024.

Double Track Truss Bridge with Suspended Tracks. Illustrated description of an interesting structure at Conneaut Harbor, Ohio, now under construction. 300 w. Ry Age Gaz—July 8, 1910. No. 15469.

The Hudson River Bridge at Waterford, N. Y. Brief illustrated description of the old Burr-truss bridge, destroyed by fire July 10, 1909, and the new steel truss superstructure placed on the old piers. 1000 w. Eng News—July 14, 1910. No. 15588.

Swing Bridges.

The Langebro Harbor Bridge, Copenhagen. Plate and description of the construction of a swing-bridge in Denmark, having elaborate hydraulic machinery, and unusual features. 8500 w. Engng—June 10, 1910. Serial. 1st part. No. 15497 A.

Viaducts.

Portcreek Viaduct. A substantial wrought-iron and steel structure, replacing a timber viaduct, is illustrated and described. 600 w. Engr, Lond—June 24, 1910. No. 15552 A.

The Design and Construction of the Paulin's Kill Viaduct. Illustrated description of this reinforced-concrete structure which carries the new double-track cut-off of the D., L. & W. R. R. across the Paulin's Kill valley. 2500 w. Eng Rec—July 16, 1910. No. 15627.

A Notable Bridge. Brief illustrated description of the Assopos viaduct on the Piraeus Railway, Greece, and its erection. 1000 w. Sci Am Sup—July 2, 1910. No. 15403.

The Gorgopotamos Viaduct, Greece (Le Viaduc du Gorgopotamos, Grèce). Georges Bodin. Describes an important steel structure on the Grecian Railway.

Ills. 2000 w. Génie Civil—June 18, 1910. No. 15737 D.

Elevated Street Crossing at the Kieritzsch Station (Strassenuberfuhrung auf Bahnhof Kieritzsch). Em. Haimovici. Detailed description of a short reinforced concrete viaduct. Ills. 2500 w. Beton u Eisen—June 10, 1910. No. 15933 F.

CONSTRUCTION.

Architecture.

Architectural Treatment of Engineering Structures (Ingenieurarchitekturen). W. Franz. A plea for the aesthetic treatment of engineering structures. Ills. 2000 w. Tech u Wirt—June, 1910. No. 15958 D.

Columns.

See Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Concrete.

Notes on Concrete Construction. Robert A. Cummings. Discusses the relation of construction to design, methods of construction, etc., illustrating and describing work. Short discussion. 7000 w. Pro Engrs' Soc of W Penn—June 1910. No. 15817 D.

The Construction of Concrete Fence Posts. Considers the comparative advantages of concrete and wooden posts, the materials for making concrete, methods, etc. Ills. 8500 w. U S Dept of Agri, Bul. 403—May 21, 1910. No. 16006 N.

European Concrete and Stucco Work. Rolf R. Newman. Descriptive notes and photographs taken during the summer of 1909. 3000 w. Cement Age—July, 1910. No. 15812.

Novel Uses of Concrete in One of California's Largest Wine Plants. Horatio F. Stoll. Illustrates and describes uses at the Italian-Swiss Colony's dry wine vineyard and winery at Asti. 1500 w. Cement Age—July, 1910. No. 15811.

An Experiment to Determine the Pressure of Concrete Upon Forms. L. E. Ashley. Describes apparatus used in a test made at the University of Illinois, giving results. 800 w. Eng News—June 30, 1910. No. 15398.

Earth Pressures.

Bracing and Sheeting Trenches. Frank H. Carter. Explains the writer's methods and practice in computing pressures on bracing and shoring. 1200 w. Engng-Con—July 27, 1910. No. 16016.

Earthwork.

Methods and Cost of Steam Shovel Work Loading Slag, Earth, and Sand into Cars for Railway Ballasting and Grading. D. A. Wallace. 800 w. Engng-Con—July 27, 1910. No. 16015.

Methods of Making Deep Fills by Suspending Track from Cableway. Discussion, by F. E. Cudworth and Daniel J. Hauer, on schemes for embankment construction. 3000 w. Engng-Con—July 20, 1910. No. 15690.

Excavation.

See Rock Removal, under WATERWAYS AND HARBORS.

Excavators.

A Giant Steam Excavator. Illustrates and describes a new type of steam crane excavator invented by A. R. Grossmith. 2000 w. Sci Am—July 9, 1910. No. 15412.

Floors.

Hollow-Tile Floor Construction without Girders (Nouveau Plancher à Briques creuses sans Poutres). H. Deniau. A brief description of the new Faber system. Ills. Serial. 1st part. 1500 w. Rev Indus—June 25, 1910. No. 15731 D.

Foundations.

Testing Soil Below the Surface for Foundation Loads. Illustrates and describes methods used to investigate the bearing capacity of the soil at a considerable depth below curb. 1200 w. Eng Rec—July 16, 1910. No. 15629.

Foundation Work on the Municipal Building, New York. Information concerning changes agreed upon in connection with the foundation work for a $11,000,000 building in the Brooklyn Bridge plaza. Diagrams. 2500 w. Eng Rec—July 9, 1910. No. 15455.

A Municipal Building of the City of New York. Illustration and interesting facts concerning the $10,000,000 building under construction near the terminus of the Brooklyn Bridge. It has the deepest foundations in the world—144 feet below curb. 1500 w. Sci Am—July 16, 1910. No. 15598.

Pile Cutting.

A Machine for Cutting Off Submerged Piles to Exact Elevation. From a paper by Clarence Coleman. Illustrated description of the device. 1000 w. Engng-Con—June 29, 1910. No. 15335.

Piling.

Failure of Concrete Piles Under Ocean Pier at Long Beach, Cal. L. A. Waterbury. Brief account, with illustration, and editorial note. 1000 w. Eng News—July 21, 1910. No. 15803.

Regulations.

Criticism of the Standards of Reinforced-Concrete Construction of Various Countries (Critica delle Norme vigenti per le Costruzioni di Cemento armato nei vari Stati). Deals with the regulations in force in the principal countries of Europe. 4000 w. Il Cemento—June 30, 1910. No. 15758 D.

Reinforced Concrete.

Graphical Design of Reinforced Concrete Structures (Graphostatische Berechnung von Konstruktionen aus Eisenbeton). K. Bakker. Mathematical discussion of bending and axial loads. Ills. 2000 w. Beton u Eisen—June 10, 1910. No. 15935 F.

Retaining Walls.

Comparative Sections of Thirty Retaining Walls and Some Notes on Retaining

Wall Design. Frank H. Carter. Diagrams. 1200 w. Eng News—July 28, 1910. No. 16030.

Steel.

A New Method of Proportioning Webs and Stiffeners in Plate Girders. H. M. Gibb. A mathematical determination, illustrated by a special case. 2000 w. Engng —July 8, 1910. No. 15671 A.

The Design of Riveted Brackets. W. T. S. Butlin. Refers to an article by Munroe R. Hall in *Eng. News,* showing the limitation of the method, and that a formula may be obtained having the widest application. 1800 w. Engr, Lond—July 8, 1910. No. 15679 A.

General Features of the Curtis Building, Philadelphia. A fireproof steel cage structure occupying a city block and having a height of ten full stories, designed for the requirements of a large publishing business. Ills. 4500 w. Eng Rec—July 9, 1910. No. 15454.

Erection of the Curtis Building, Philadelphia. Illutsrates and describes erection methods of interest because of their magnitude, the conditions, rapid work, and carefully planned details. 2500 w. Eng Rec—July 16, 1910. No. 15630.

The Extension of the Columbia Building, New York. Describes methods used in adding three additional stories to a 12-story building, without disturbing tenants. 1800 w. Eng Rec—July 23, 1910. No. 15881.

Theatres.

The Shea Theatre from an Engineering Point of View. A. C. Oxley. Detailed description of fireproof construction of a theatre building in Toronto, Canada. Ills. 2500 w. Can Engr—July 7, 1910. No. 15480.

Trenches.

See Earth Pressures, under Construction.

Tunnel Lining.

Method and Cost of Constructing a Concrete Tunnel Lining with an 80 Ft. Gravity Chute. W. D'Rohan. Report of work in connection with irrigation in Colorado. 1500 w. Engng-Con—July 6, 1910. No. 15492.

Tunnels.

Reconstruction of the Washington St. Tunnel Under the Chicago River. Illustrated description of unusual tunnel work, explaining conditions. 4500 w. Eng News—July 21, 1910. No. 15866.

The Laramie Poudre Tunnel. An account of the progress on this tunnel in Colorado which will bring the waters from the Laramie River into the Cache La Poudre River for irrigation. 1500 w. Eng Rec—July 2, 1910. No. 15388.

The Paris Metropolitan Railway. Illustrated detailed description of the exceptionally difficult work of forming the tunnels under the two branches of the Seine. Based on an article in *Le Génie Civil.* 2000 w. Engr, Lond—July 1, 1910. No. 15557 A.

Tunnelling Under the Seine by the Freezing Process. Illustrated description of interesting engineering work in the construction of the Paris Metropolitan Ry., near St. Michel Station. 1500 w. Builder —June 25, 1910. No. 15502 A.

The Construction of the Lötschberg Tunnel (I Lavori al Tunnel del Lötschberg). A detailed report of progress by months and by quarters since April 1, 1909. 4200 w. Monit Tech—June 30, 1910. No. 15754 D.

Underpinning.

Underpinning the Astor Building, New York. Describes underpinning a 7- and 8-story building in New York, during the construction of foundations for an adjoining 42-story building. 2000 w. Eng Rec—July 2, 1910. No. 15390.

Wage Systems.

Experience with Day Labor Work in the Maintenance and Repairs of Bridges in Chicago, Ill. Information from the recent report of Chicago Commission on City Expenditures. 5000 w. Engng-Con —June 29, 1910. No. 15334.

MATERIALS OF CONSTRUCTION.

Cement.

The Effect of Sea Water, Alkali Water, and Sewage on Portland Cement and Methods Used for Counteracting Same. W. D'Rohan. Reviews the theories advanced to account for the destruction, the causes, and the remedies. 5000 w. Engng-Con—July 20, 1910. No. 15680.

Recent Investigations on the Constitution of Portland Cement. Clifford Richardson. Describes the origin and method of production, the structure and constitution. 3500 w. Eng Rec—July 10, 1910. No. 15632.

Concrete.

The Effect of Sodium Silicate on Concrete. Albert Mover. Read before the Am. Soc. for Test. Mat. Gives results of experiemnts. 1500 w. Eng Rec—July 23, 1910. No. 15883.

Long Time Tests on Concrete in Sea Water. A. Poulsen. Report presented to the Fifth Congress of the Int. Assn. for Test. Mat. 2000 w. Eng News—July 7, 1910. No. 15407.

See also Aqueducts, under Water Supply.

Paints.

Exposure Tests of Structural Steel Coatings. Cloyd M. Chapman. Read before the Am. Soc. for Test. Mat. Describes tests and reports ratings of 530 different paints after one- and two-year terms of service. Ills. 2000 w. Ir Age—July 14, 1910. No. 15508.

Reinforced Concrete.

Repeated and Eccentric Load Tests of Reinforced-Concrete Columns. M. O.

Withey. Read before the Am. Soc. for Test. Mat. Reports results of tests made on some very strong spirally reinforced columns at the University of Wisconsin. 2500 w. Eng Rec—July 9, 1910. No. 15458.

Steel.

The Condition of the Steel of the Gillender Building; A Preliminary Report. Maximilian Toch. A statement of the condition of the framework of a 14-year-old building, now being removed, which is reassuring. Ills. 800 w. Eng News—July 14, 1910. No. 15595.

Strength of Steel in I-Beams. E. L. Hancock. Read before the Am. Soc. for Test. Mat. Micrographs and report of tests. 1500 w. Eng Rec—July 9, 1910. No. 15456.

Stucco.

Cement Stucco. Albert Moyer. Suggestions for the successful use of this material. 2000 w. Munic Engng—July, 1910. No. 15850 C.

Timber.

Lumber. F. R. Babcock. Considers the sources, cutting, grading, curing, etc. Discussion. 4500 w. Pro Engrs' Soc of W Penn—June, 1910. No. 15818 D.

Tests of Timber Beams. Arthur N. Talbot. A report of methods of testing, giving experimental data and discussion. Ills. 15000 w. Univ of Ill, Bul 41—Dec. 12, 1909. No. 15815 N.

Timber Preservation.

Wood Preservation from an Engineering Standpoint. C. T. Barnum. Discusses preservatives, treating processes, length of life, and economic considerations. General discussion. 10000 w. Jour W Soc of Engrs—June, 1910. No. 15855 D.

Creosote for Wood Blocks. Richard Lamb. Plea for use of standard dead oil of coal tar. 1200 w. Munic Jour & Engr—July 6, 1910. No. 15420.

Preservation of Wooden Poles by Impregnation with Fluorides (Konservierung hölzerner Leitungsmaste durch Tränkung mit Fluoriden). Robert Nowotny. Describes the zinc-fluoride process of timber preservation and gives results Ills. 3600 w. Elektrotech u Maschinenbau—June 12, 1910. No. 15943 D.

MEASUREMENT.

Bituminous-Materials Testing.

An Instrument for Ascertaining the Tenacity and Ductility of Bituminous Materials. Herbert Abraham. Read before the Am. Soc. for Test. Mat. Illustrates and describes an improved instrument. 1800 w. Engng-Con—July 20, 1910. No. 15691.

The Determination of Soluble Bitumen. Provost Hubbard and C. S. Reeve. Paper before the Am. Soc. for Test. Mat. A report of investigations and methods used, giving results. 3000 w. Engng-Con—July 6 1910. No. 15493.

Proposed Standard Tests for Road Materials of the American Society for Testing Materials. 2000 w. Engng-Con—July 20, 1910. No. 15692.

Surveying.

Methods and Costs of Midwinter Surveying; The St. Louis and Cloquet River Surveys, Minnesota. C. R. Adams. Information concerning surveys in Minnesota to investigate the water resources. Ills. 2200 w. Eng News—July 28, 1910. No. 16028.

MUNICIPAL.

Pavements.

See Timber Preservation, under MATERIALS OF CONSTRUCTION.

Philippines.

District Engineer Work in the Philippines. William Goldsmith. An account of the good-road work and its benefits, the government buildings, culverts, bridges, etc. Ills. 2000 w. Eng News—July 7, 1910. No. 15406.

Power Plants.

Motive Powers for Municipal Engineers. Arthur E. Collins. Read before the Incor. Assn. of Munic. & Co. Engrs. Discusses various methods of obtaining motive power for water supply, sewage pumping, workshop driving, and other purposes. 4000 w. Surveyor—July 1, 1910. Serial. 1st part. No. 15528 A.

Public Baths.

The Vienna Municipal Baths (Die städtischen Volksbäder in Wien). Franz Wejmola. Describes their construction and administration. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—June 24, 1910. No. 15928 D.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. On the utilization of residuals from refuse destructors. 2500 w. Munic Engng—July, 1910. No. 15848 C.

The Design and Working of a Modern Refuse Destructor. William F. Loveday. Abstract of paper read before the Incor. Assn. of Munic. & Co. Engrs. A review of types and the methods of operating. 2500 w. Mech Engr—July 8, 1910. No. 15666 A.

Chicago Waste Disposal System. Illustrated description of the disposal station which receives the wastes and loads the material on scows for transportation to places where it is used for reclamation purposes. 1800 w. Eng Rec—July 2, 1910. No. 15386.

Milwaukee Incinerating Plant. Describes method of testing this important plant. 2000 w. Munic Jour & Engr—June 29, 1910. No. 15309.

The Construction and Testing of the Milwaukee Refuse Incinerator. Samuel A. Greeley. Describes the design, construction and tests of a new incinerator which promises success. Ills. 7000 w. Eng News—July 21, 1910. No. 15802.

Tests of the Milwaukee Refuse Destructor. Illustrates and describes one of the largest plants of the kind in the United States, reporting the satisfactory tests. 3000 w. Eng Rec—July 16, 1910. No. 15625.

Westmount Incinerator and Power Plant. George W. Thompson. Describes the use of refuse destructors for generating electric light and power for this city in Quebec, Canada. 2500 w. Can Elec News—July, 1910. No. 15448.

Road Rollers.

The Management and Care of Steam Road-Rollers. Wilfred Eddison. Suggestions. 1800 w. Surveyor—July 8, 1910. Serial. 1st part. No. 15664 A.

A Road Roller of Improved Design with Novel Form of Front Truck. Illustrated description of the Geiser road roller, explaining its advantages. 2500 w. Eng News—July 7, 1910. No. 15408.

Roads.

Dynamic Relations between Wheel and Road (Relations dynamiques entre la Voiture et la Route). A. Petot. A study of the effect of automobiles on roads. Ills. Serial. 1st part. 4500 w. Tech Mod—June, 1910. No. 15723 D.

Roads and Automobile Traffic in Italy (Le Strade e l'Automobilismo in Italia). Domenico Ruggeri. Discusses road construction and maintenance, and the use of automobiles for public service. Ills. 6500 w. Ann d Soc d Ing e d Arch Ital—June 1, 1910. No. 15748 F.

The Value of Rise-and-Fall Elimination on Streets and Roads. Editorial on the cost of rise-and-fall in street and road improvements and the gain from the elimination. 2500 w. Eng News—July 14, 1910. No. 15593.

Improved Highways in Fulton County Georgia. William H. Stone. Illustrated description of work in the construction of improved roads. 1500 w. Mfrs' Rec—July 7, 1910. No. 15394.

Highway Construction in Cuba. From a paper by Mason M. Patrick, in *Prof. Mem.* Describes the construction of four roads in the Province of Pinar del Rio. 6000 w. Engng-Con—July 27, 1910. No. 16017.

Progress Reports of Experiments in Dust Prevention and Road Preservation. Logan Waller Page. Describes experiments and reports results obtained. 12500 w. U S Dept of Agri—Circular 92. No. 15985 N.

Experiments of the State Highway Department of Ohio with Various Road Binding Materials. Describes experiments made on a road near Columbus, Ohio. 5000 w. Engng-Con—July 6, 1910. No. 15494.

Tar for Road Works. R. O. Wynne-Roberts. Discusses methods of production, and their effect on the quality. 3000 w. Surveyor—July 1, 1910. Serial. 1st part. No. 15527 A.

Sewage Disposal.

Modern Biological Sewage Treatment. W. J. Dibdin. Presidential address delivered before the Assn. of Mgrs. of Sewage Disposal Works at Northampton, Eng. 2000 w. Surveyor—July 8, 1910. Serial. 1st part. No. 15665 A.

Rapid Sewage Sedimentation. Emil Kuichling. Abstract of experimental investigations on the sedimentation of sewage at Cologne, Germany, made by City Engineer Steuernagel. 2500 w. Munic Jour & Engr—July 20, 1910. No. 15820.

The Calumet-Sag Channel of the Chicago Drainage Canal Recommended as the Best Means of Sewage Disposal for the Calumet District. Gives a report submitted on the question of disposing of the sewage of this district of Chicago. 2000 w. Engng-Con—June 29, 1910. No. 15333.

Septic Tank and Contact Beds for Treating the Sewage of Cherryvale, Kan. J. S. Worley. States the conditions and gives an illustrated description of the contact beds for treating effluent from septic tank. 1500 w. Eng News—June 30, 1910. No. 15397.

Sewage Disposal for a School Building. O. B. Craig. Directions for building a combined septic tank and filter bed, explaining the purification process. Ills. 2500 w. Met Work—July 23, 1910. No. 15863.

A Septic Tank for Isolated Houses (Fosse septique pour Habitations isolées). Describes a simple system of sewage disposal for isolated houses or small communities. Ills. 2000 w. Génie Civil—June 25, 1910. No. 15741 D.

Sewage Pumping.

See Sewers, under MUNICIPAL.

Sewers.

New Sewers and Sewage Pumps at Richmond. Explains conditions, and gives illustrated description of the new sewage and pumping station. 2000 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15682 A.

Difficult Sewer Reconstruction. Illustrates and describes methods used in replacing a sewer in Duane Street, New York City, made necessary by the construction of the Bridge Loop subway. 2500 w. Eng Rec—July 9, 1910. No. 15450.

Street Cleaning.

Modern Methods of Street Cleaning. George A. Soper. Portions of an address before the first New England Conference on Street Cleaning. 1500 w. Eng News—July 28, 1910. No. 16027.

New York Street Cleaning. Illustrates and describes the methods and extent of the work and the disposal of refuse. 4500 w. Munic Jour & Engr—July 13, 1910. No. 15604.

WATER SUPPLY.

Aqueducts.

Further Tests of Models of the Medina Aqueduct Arch. Illustrated general description of the second series of tests, giving results. 1800 w. Eng Rec—July 9, 1910. No. 15450.

Second Series of Concrete Model-Arch Tests for Medina Aqueduct, New York State Barge Canal. Gives results of these tests. Ills. 1200 w. Eng News—July 7, 1910. No. 15410.

The Owens Valley and Olancha Divisions of the Los Angeles Aqueduct. Illustrates and describes the construction methods used for the open canal sections of this work, having a length of 60 miles. 3300 w. Eng Rec—July 2, 1910. No. 15389.

Electricity in the Construction of the Los Angeles Aqueduct. Illustrated description of the power system, and the applications of electricity. 3000 w. Eng Rec—July 16, 1910. No. 15633.

A New Aqueduct for Genoa (Per un nuovo Acquedotto a Servizio della Citta di Genova). Describes a project for increasing the water supply of Genoa. Ills. 3000 w. Monit Tech—May 30, 1910. No. 15749 D.

Some Roman Hydraulic Works (Di alcune Opere idrauliche Romane). G. de Angelis d'Ossat. Describes and discusses Roman aqueducts and conduits. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—May 15, 1910. No. 15747 F.

Conduits.

A Reinforced-Concrete Conduit Operating Under a Head. Explains conditions at Salt Lake City, Utah, and gives illustrated description of the method of building a circular conduit. 1800 w. Eng Rec—July 23, 1910. No. 15885.

The New Cast-Iron Conduit of the Syracuse Water Works. Illustrated description of a line 19 miles long recently laid between Skaneatles Lake and Woodland reservoir; made necessary by the growth of the city. 3500 w. Eng Rec—July 2, 1910. No. 15392.

Dams.

British Views Regarding Earth Dams. Abstract of a paper by George N. Yourdi, before the British Assn. of Water Engrs. Also of discussion. 2000 w. Eng Rec—July 9, 1910. No. 15457.

The Shoshone Dam of the United States Reclamation Service. D. W. Cole. Map and illustrated detailed description of the method of constructing the highest dam in the world, on the Shoshone River, Wyoming. Plate. 7800 w. Eng Rec—July 23, 1910. No. 15878.

The Chaudiere Dam, Ottawa, Canada. Douglas L. McLean. Illustrates and describes an interesting type of stop-log dam on the Ottawa River. It is of steel and concrete construction and of the pier-and-sluice type. 2200 w. Eng News—June 30, 1910. No. 15395.

Methods and Cost of Constructing Concrete Core Wall in Moline Pool Dam in Mississippi River at Moline, Ill. J. B. Bassett, in *Prof. Mem.*, Engineer School, Washington, D. C. Illustrated description of methods and statement of cost. 1700 w. Engng-Con—July 27, 1910. No. 16014.

Replacement of Timber with Reinforced-Concrete Sills in the Chanoine Navigation Passages of the Moveable Dams of the Upper Seine (Remplacement des Seuils en Bois des Passes navigables—du Système Chanoine—de la Haute-Seine par des Seuils en Béton armé). M. Imbs. Describes methods and cost of the work. Ills. 3000 w. Ann d Ponts et Chaussées—1910—III. No. 15743 E + F.

Disinfection.

Hypochlorite Disinfection of the Water-Supply of Toronto, Ont. T. Aird Murray. Information relating to the reduction of bacteria and the total elimination of intestinal bacteria, by the temporary use of hypochlorite as a disinfectant. 1200 w. Eng News—July 21, 1910. No. 15805.

Filtration.

A Mechanical Filter for the Removal of Iron. A plant in Iowa City, Ia., for the removal of iron by precipitation with lime and subsequent mechanical filtration, is illustrated and described. 1800 w. Eng Rec—July 23, 1910. No. 15882.

Fire Protection.

High-Pressure Fire Protection System at Oakland, Cal. Illustrated description of the salt water, high-pressure, fire protection system recently put in operation. 3500 w. Eng Rec—July 23, 1910. No. 15880.

Genoa.

See Aqueducts, under WATER SUPPLY.

Havana.

Notes on the Water-Supply of Havana, Cuba. R. Winthrop Pratt. Brief illustrated description of the antique filter plant and the present water supply system. 1200 w. Eng News—July 14, 1910. No. 15591.

Illinois.

The Quality of the Surface Waters of Illinois. W. D. Collins. Report of investigations made, furnishing means of stating the quality of the water which may be found at any point along the larger streams within or bordering the State. Map. 27000 w. U S Geol Survey—Paper 239. No. 15285 N.

Irrigation.

Irrigation and Electrical Energy. Illustrates and describes the hydroelectric features of some of the projects of the reclamation service in the United States. 2000 w. Elec Wld—July 7, 1910. No. 15481.

The Relative Value of Irrigating Waters. Herman Stabler. A discussion of the alkali problem, giving tables and information based on irrigation practice in the United States. 1800 w. Eng News—July 14, 1910. No. 15597.

Irrigation in Siam (Mededeelingen betreffende de Werkzaamheden bij het Irrigatie-Departement in Siam). J. van Tubergen. Describes recent developments. 8000 w. De Ingenieur—June 4, 1910. No. 15964 D.

See also Electric Pumping, under MECHANICAL ENGINEERING, Hydraulics.

Pipe Flow.

Flow of Water in Curved Pipes. John Eustice. Read before the Roy. Soc. An account of investigations to determine the variation in the resistance to the flow of water in pipes due to the curvature. 2500 w. Engr, Lond—July 1, 1910. No. 15567 A.

Pipe Lines.

Allievi's Theory of Pressure Variations in Pipe Lines (Bemerkungen zur Alievischen Theorie der Druckschwankungen in Rohrleitungen). E. Braun. Mathematical and graphical presentation. Ills. Serial. 1st part. 1700 w. Die Turbine—June 20, 1910. No. 15909 D.

The Pipe Lines of the Kinloch-Leven Hydroelectric Plant (Die Rohrleitungen der hydroelektrischen Anlage Kinloch-Leven). E. Liersch. Detailed description of the design and construction. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—June 27, 1910. No. 15947 D.

Reservoirs.

Making a Stream Excavate Its Own Reservoir and Build Its Own Dam. Burt A. Heinly. Describes methods of constructing which have become popular in the West. Ills. 1000 w. Munic Engng—July, 1910. No. 15849 C.

Siphons.

Reinforced-Concrete Siphon for a 65-Foot Head. Illustrated description of siphons built in connection with the Los Angeles Aqueduct. 1600 w. Eng Rec—July 9, 1910. No. 15453.

Sterilization.

The Ultra-Violet Rays and Their Industrial Application to the Sterilization of Water and other Liquids (Les Rayons ultra-violet et leur Application industrielle à la Stérilisation des Eaux et autres Liquides). Dr. Nogier. A review of the process and its practical application. 6000 w. Tech Mod—June, 1910. (Sup.) No. 15720 D.

Stream Discharge.

Discharges of Glacial Streams (Considérations sur les Débits industriels des Cours d'Eau de Régime glaciaire). A. Boucher and H. Chenaud. Gives charts showing variations in discharge from year to year of streams fed by glaciers. 1200 w. Bul Tech d l Suisse Rom—June 10, 1910. No. 15729 D.

Stream Flow.

What Stream Gagings Indicate as to the Run-Off from Forested and Barren Areas. A letter from Farley Garinett, on the relations between deforestation and stream flow. 2500 w. Eng News—June 30, 1910. No. 15401.

Tanks.

Weights of Cylindrical Pressure Tanks. C. R. Whittier. Tables, diagram, and method of calculating. 1000 w. Mach, N Y—July, 1910. No. 15376 C.

WATERWAYS AND HARBORS.

Barge Canal.

The Erie Canal. Charles Prelini. First of a series of articles aiming to show the great historical, commercial, and political influence of the old Erie Canal, and to forecast the conditions that will arise from the improvements now in progress. 2500 w. Engng—July 1, 1910. Serial. 1st part. No. 15540 A.

Columbia River.

A 30-Year Record of Flow for the Columbia River. Abstracts of paper, No. 252, of the U. S. Geol. Survey, giving a summary of a notable record. 700 w. Eng News—June 30, 1910. No. 15400.

Constanza.

The New Harbor Works at Constanza, Roumania. Fr. Bock. Illustrated description of important improvements at this great grain port, on the Black Sea. 1500 w. Cassier's Mag—July, 1910. No. 15649 B.

Dry Docks.

Progress on Dry Dock No. 4, Brooklyn Navy Yard. An illustrated account of the difficulties met, the changes in original plans, and the progress of this work. 5000 w. Eng Rec—July 2, 1910. No. 15385.

The 22000-Ton Floating Dock for Brazil. Illustrated detailed description of the Rio de Janeiro dock built in Great Britain. 2000 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15680 A.

The Dry Dock of the Société de la Gironde at Bordeaux (Le Bassin à Flot de la Société de la Gironde à Bordeaux). M. Michel-Schmidt. Describes its construction under difficult conditions. Ills. 18500 w. Mem Soc Ing Civ de France—April, 1910. No. 15706 G.

Italy.

Navigation from Lake Como to Milan (Per la Navigazione Lago di Como-Milans). N. Sacerdoti. Discusses the possibility of rendering the Adda navigable. Ills. 4000 w. Monit Tech—June 30, 1910. No. 15752 D.

Jamaica Bay.

Jamaica Bay Improvements. Illustration and brief account of a scheme of construction of channels, bulkheads, and the reclamation of land which, when completed, will provide the port of New York with 150 additional miles of water front. 1200 w. Sci Am—July 2, 1910. No. 15402.

Locks.

Locks and Weirs in the Weser at Bremen (Die Schleusen und Wehranlage in der Weser bei Bremen). Herr Oeltjen. Brief description. Ills. 1500 w. Deutsche Bau—June 18, 1910. No. 15907 B.

Loire.

The Works of "The Navigable Loire" (Les Travaux de "la Loire navigable"). Ch. Dantin. Describes the works carried out by the Navigable-Loire Association, a local society for the improvement of this French river. Ills. 5000 w. Génie Civil—June 25, 1910. No. 15739 D.

New York.

Report of Transportation Conditions at the Port of New York. Submitted by Calvin Tomkins, Commissioner of Docks. Especial reference to a joint railroad terminal in Manhattan on the North River above 25th Street. Plans. 7500 w. Dept of Locks & Ferries, New York—July, 1910. No. 15814 N.

Panama Canal.

The Construction of the Panama Canal (Vom Bau des Panama-Kanals). Hans Raschka. A discussion of the methods and progress of the work. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—June 17, 1910. No. 15927 D.

Piers.

An Improvement in Pier Construction, San Francisco. Describes an improved method developed in constructing two piers in China Basin. Ills. 1200 w. Eng Rec—July 16, 1910. No. 15626.

New Concrete Piers at San Francisco. Illustrated description of the new steel and concrete piers and their construction. 1500 w. Marine Rev—July, 1910. No. 15602.

Pollution.

West Riding Rivers: 1904-1910. First of a series of articles dealing with the work of the West Riding Rivers Board, and the inaction of the Local Government Board, in regard to the purifying of polluted rivers. 4500 w. Engng—July 8, 1910. Serial. 1st part. No. 15676 A.

Port Said.

Port Said Harbor in 1909 (Der Hafen von Port Said im Jahre 1909). Describes recent extensions and improvements to the harbor works. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—June 18, 1910. No. 15931 D.

Rock Removal.

The Submarine Rock Breaker in Trieste Harbor (Dérocheuse sous-marine du Port de Trieste). Brief description of the percussion breaker and the float on which it is carried. Ills. 1000 w. Génie Civil—June 4, 1910. No. 15733 D.

Shore Detritus.

The Accumulation of Shore Detritus During an Off-Shore Wind. A. H. Gibson. An explanation of the cause of this phenomenon. 2500 w. Engr, Lond—June 24, 1910. No. 15546 A.

Water Powers.

Utilization, Preservation and Conservation of Water Power. L. G. Carpenter. Slightly condensed address before the Colorado Conservation Commission. 1600 w. Eng Rec—July 23, 1910. No. 15879.

Wharves.

The Municipal Wharf at Montgomery, Ala.; A Novel Solution of the River Loading Problem. G. C. Scherer. Illustrated description of a double railroad track on concrete piers on which a movable wharf is lowered or hoisted. 500 w. Eng News—July 14, 1910. No. 15596.

Riverside Quay, Hull. Illustrated detailed description of a deep-water quay recently constructed in the Humber River for the improvement of port facilities. 1200 w. Engr, Lond—July 1, 1910. No. 15560 A.

MISCELLANY.

Contracts.

Standardizing Public Works Contracts. R. Walter Creuzbaur. Abstract of a paper, "The Necessity for Standardizing Contracts of the City of New York," read before the Nat. Assn. of Comptrollers and Acc. Officers. 2400 w. Eng News—July 28, 1910. No. 16026.

The Necessity for Standardizing Contract Forms. Condensed address, by R. Walter Creuzbaur, before the Nat. Assn. of Comptrollers and Accounting Officers. 2200 w. Eng Rec—July 2, 1910. No. 15391.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

The Chambers Liquid Microphone. F. J. Chambers. Illustrated description of a novel form of transmitter, describing practical results. 1500 w. Elect'n, Lond—July 15, 1910. No. 15894 A.

A New System of Wireless Telegraphy. Illustrated description of the Bellini-Tosi apparatus. 1500 w. Sci Am Sup—July 16, 1910. No. 15600.

A Wireless Telegraph Station. Edward H. Guilford. Explains how to construct a 1000 miles receiving station. Ills. 2000 w. Sci Am Sup—July 23, 1910. Serial. 1st part. No. 15810.

Wireless Telegraphy (La Télégraphie sans Fil). S. Van Mierlo. A general review of theory, practice, apparatus, systems, etc., with statistics of established stations. Ills. 4500 w. Bul Sci d l'Assn d Elèves—April, 1910. No. 15700 D.

Telantograph.

The Walbrook Telewriter Exchange. Describes an exchange connected to about 50 subscribers in London. Ills. 1000 w. Elect'n, Lond—July 1, 1910. No. 15523 A.

Telegraphy.

American Telegraph Engineering—Notes on History and Practice. William Maver, Jr., and Donald McNicol. Gives a résumé of the early history of telegraph practice in America, and describes features of present practice. 12000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15282 F.

Developments in Telegraphy and Telephony. Sir John Gavey. Abstract of the "James Forrest" lecture before the Inst. of Civ. Engrs. A review of the rápid and important developments in the service. 4000 w. Elec Engr, Lond—July 1, 1910. Serial. 1st part. No. 15512 A.

Modern Submarine Telegraphy. Sidney G. Brown. Lecture at the Roy. Inst. Illustrates and describes the submarine cable and its electrical properties, mechanical difficulties, the instruments that work the cables, etc. 7000 w. Nature—July 7, 1910. No. 15655 A.

Telephony.

The History of the Telephone. Herbert N. Casson. First of a series of articles dealing with the telephone and telephone system. 3500 w. Elec Rev, N Y—July 9, 1910. Serial. 1st part. No. 15488.

DISTRIBUTION.

Switches.

Varied Applications of Tumbler Switches. Ewart B. Walker. Describes a few interesting applications. 500 w. Can Elec News—July, 1910. No. 15446.

DYNAMOS AND MOTORS.

A. C. Dynamos.

An Improvement in Single-Phase Alternators. Prof. C. Pichel-Mayer. Abstract translation from *Electrotechnische Zeit.* Describes means of avoiding dangerous pressures and of making the factor of safety equal to that of polyphase machines. 1200 w. Elect'n, Lond—June 24, 1910. No. 15520 A.

The Compounding of Alternators. A. Blondel. Slightly abbreviated from *Bul. de la Soc. Int. des Electns.* Describes the author's system and gives detail installations and test results. 2500 w. Elect'n, Lond—July 15, 1910. No. 15803 A.

A. C. Motors.

The Scherbius Motor and Some Methods of Working It in Cascade with Induction Motors. Reginald O. Kapp. Shows how this motor has been used to impart to the induction-motor the desired variable-speed characteristic. Ills. 5000 w. Elect'n, Lond—July 8, 1910. No. 15661 A.

Induction Motors.

Space Distribution of Magnetomotive Force. B. B. Brackett. A study of the magnetizing current in the three-phase induction motor. 1500 w. Elec Wld—July 28, 1910. No. 16022.

See also A. C. Motors, under DYNAMOS AND MOTORS.

Motor Reversing.

Reversing Motors. J. S. McKee. Gives curves showing the operation in motor reversing under stated conditions, and facts related. 1500 w. Sci Am Sup—July 16, 1910. No. 15599.

Starting Rheostats.

Method of Calculating Starting Rheostats for Continuous-Current Motors (Metodo per Calcolare i Reostati d'Avviamento dei Motori a Corrente continua). Carlo Righini. Mathematical demonstration. Ills. 2000 w. Industria—June 5, 1910. No. 15755 D.

Synchronizing.

The Sensitiveness of Synchronizing Apparatus. J. Teichmüller. Abstract translation from *Elektrotechnische Zeit.* Illustrates systems of connection and examines their sensitiveness. 1200 w. Elect'n, Lond—June 24, 1910. No. 15522 A.

Voltage Regulation.

The New Wolff Regulating System for Hydroelectric Plants (Das neue Wolffsche Reguliersystem für hydroelektrische Kraftanlagen). F. Simmerding. Detailed description of the apparatus. Ills. 1500 w. Elektrotech u Maschinenbau—June 12, 1910. No. 15944 D.

ELECTRO-CHEMISTRY.

Corrosion.

The Corrosion of Iron and Steel. Report of Committee A5 of the American Society for Testing Materials. 4000 w. Eng Rec—July 9, 1910. No. 15451.

The Formation of Rust (La Formation de la Rouille). G. Bresch. A review of theories of iron corrosion. Ills. 4500 w. Rev de Métal—June, 1910. No. 15711 E + F.

Electric Furnaces.

Current and Voltage Conditions in the Electric Furnace (Ueber Strom- und Spannungsverhältnisse im elektrischen Ofen). Walter Conrad. Read at the Düsseldorf Congress. A discussion of the application of energy in electric furnaces. Ills. 2200 w. Stahl u Eisen—June 22, 1910. No. 15779 D.

Electrodes.

A Graphite Cathode Dish. J. W. Turrentine. Abstract of paper before the Am. Elec.-Chem. Soc. Describes simple graphite electrodes designed for use in place of platinum as insoluble electrodes in electrochemical experiments. Reports experiments with a graphite dish intended to supplant the Classen platinum dish. 1500 w. Elect'n, Lond—June 24, 1910. No. 15521 A.

ELECTRO-PHYSICS.

Air Strength.

The Electric Strength of Air. J. B. Whitehead. Describes an investigation to develop an accurate method of determining the electric strength of air in the neighborhood of round wires, and its application. 8000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15273 F.

Alternating Currents.

Vector Power in Alternating-Current Circuits. A. E. Kennelly. Aims to indicate the limitations under which power in an alternating-current circuit may be treated as a stationary vector, to extend the technology of vector a. c. quantities, to combat the use of the terms "wattless power" and "wattless current," and to offer a plea for standardization. Diagrams. 7000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15272 F.

Commutation.

Commutation (La Commutation). Marius Latour. A continuation and conclusion of the author's previous communication. Ills. 6000 w. Bul Soc Int des Elecns —June, 1910. No. 15708 F.

High-Frequency Discharges.

Experiments on the Destructive Effects of High-Frequency Oscillating Discharges (Quelques Experiences sur les Effets destructifs des Décharges oscilliantes de grand Fréquence). M. Courtois. Describes the experiments and illustrates the results. 2000 w. Bul Soc Int des Elecns —June, 1910. No. 15707 F.

Induction.

The Simplification of Electrical Theories (Beiträge zur Vereinheitlichung elektrischer Theorien). Hermann Zipp. An attempt to simplify the theory of all kinds of apparatus in which energy transformation occurs by means of magnetic fluxes. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—June 19, 1910. No. 15945 D.

Physiological Effects.

The Physiological Tolerance of Alternating-Current Strengths Up to Frequencies of 100,000 Cycles per Second. A. E. Kennelly and E. F. W. Alexanderson. Reports a series of tests relating to the physiological tolerance of a. c. of high frequencies. 1800 w. Elec Wld—July 21, 1910. No. 15828.

Spark Gaps.

Short Spark Gaps. D. Owen. Gives results of research work. 2200 w. Elect'n, Lond—July 1, 1910. No. 15525 A.

GENERATING STATIONS.

Accumulators.

The Use of Storage Batteries in Direct-Current and Alternating Current Central Stations. R. Werkner. Abstract translation from *Elcktrotechnick und Maschinenbau.* Discusses the relation of storage batteries to the different systems of generation and distribution. 2000 w. Elec Rev, N Y—July 23, 1910. No. 15869.

See also Boosters, under Generating Stations.

Boosters.

The Entz Reversible Booster and the Chloride Accumulator at the Blackburn Electricity Works. Illustrates and describes the successful operation of an Entz booster battery combination. 1800 w. Elec Rev, Lond—July 8, 1910. No. 15659 A.

Central Stations.

Electricity Supply in Dundee, Scotland. Robert L. Reid. An illustrated account of the new high-tension system. 4000 w. Elec Rev, N Y—July 2, 1910. Serial. 1st part. No. 15331.

See also Refuse Disposal, under CIVIL ENGINEERING, Municipal.

Construction.

Reinforced-Concrete Construction for Electric Light and Power Plants (Installation elektrischer Licht- und Kraftanlagen in Eisenbetonbauten). Siegfried Ebell. Discusses the applicability of this material to various parts of the construction. Ills. 2500 w. Beton u Eisen—June 10, 1910. No. 15934 F.

Costs.

See also Blast-Furnace Gas, under MINING AND METALLURGY, Iron and Steel.

Economics.

Commercial Progress of Electricity Undertakings. H. Collings Bishop. Read before the Munic. Elec. Engrs. Assn., Glasgow. Discusses the development of the commercial side, methods, etc. 4000 w. Elec Engr, Lond—July 15, 1910. No. 15888 A.

See also Central Plants, under MECHANICAL ENGINEERING, Heating and Cooling.

Hydroelectric.

A General Review of Hydroelectric Engineering Practice. Frank Koester. This fifth article of a series discusses high-tension transmission lines and apparatus. Ills. 4500 w. Engineering Magazine—August, 1910. No. 15999 B.

The Construction of the Great Western Power Plant. Illustrated description of construction work in California, explaining conditions. 2500 w. Eng Rec—July 16, 1910. No. 15631.

Power Developments of the Lehigh Valley Transit Company. Explains the consolidation of four railway systems under this name, and the general power arrangements, illustrating and describing the Allentown power plant, and generating equipment. 2500 w. Elec Ry Jour—July 30, 1910. No. 16034.

The Trient Electrical Works (Die Elektrizitätswerke der Stadt Trient). Ernst Rudolph. Illustrated detailed description of the water-power development of this Austrian city. Serial. 1st part.

3000 w. Elektrotech u Maschinenbau—June 26, 1910. No. 15946 D.

The Tuilière Hydro-Electric Plant on the Dordogne, and Energy Distribution in the Region of the Southwest (L'Usine hydro-électrique de Tuilière sur la Dordogne et la Distribution de l'Energie électrique dans la Région du Sud-Ouest). Albert Claveille. An exhaustive detailed description. Ills. 33000 w. Ann d Ponts et Chaussées—1910—III. No. 15742 E + F.

The Straschin-Prangschin Dam and Power Plant (Die Talsperre und das Ueberland-Kraftwerk bei Straschin-Prangschin). A. Behrendt and H. Bökenkamp. Describes an extensive power development near Danzig, Germany. Ills. 10500 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15957 D.

See also Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Isolated Plants.

Isolated Industrial Generating Installation. Albert L. Clough. Plan and description of the steam turbo-generator and induction-motor equipment of Amoskeag textile mills. 2500 w. Elec Wld—July 28, 1910. No. 16020.

Rates.

Rate Making for Public Utilities. Percy H. Thomas. Discusses the decision of the R. R. Commission of Wis. in the case of the State Jour. Printing Co. vs. the Madison Gas & Elec. Co., rendered March 8, 1910. 5000 w. Elec Jour—July, 1910. No. 15853.

Sale of Electrical Energy by the Central Colorado Power Company. Discusses the rates and methods of charging for retail service. 1200 w. Elec Wld—July 28, 1910. No. 16023.

Switchboards.

Alternating-Current Industrial Power-Plant Switchboards. Warren H. Miller. Aims to show what can be done with simple a. c. boards for various classes of service. Ills. 2500 w. Elec Rev, N Y—July 23, 1910. Serial. 1st part. No. 15870.

LIGHTING.

Arc Lamps.

Flaming Arc Lamps. Newton Harrison. Explains the means of producing light in arc lamps, how flaming arc lamps burn in circuit, and the conditions of use. 2500 w. Cent Sta—July, 1910. No. 15422.

Incandescent Lamps.

The Tungsten Lamp Situation in France. Warren H. Miller. A report of the rapid introduction of tungsten lamps in Paris. 1500 w. Elec Wld—July 7, 1910. No. 15483.

Tests of Tungsten Lamps (Untersuchungen an Wolfram-Lampen). Alois Berninger and Robert Schuster. Detailed results of tests at the Imperial Technological Institute, Vienna. Ills. Serial. 1st part. 3000 w. Elektrotechniker—June 10, 1910. No. 15938 D.

An Advance in the Construction of Glow-Lamp Fittings (Ein Fortschritt im Bau von Glühlampenarmaturen). M. Gerstmeyer. Describes recent improvements in lamp sockets. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—June 23, 1910. No. 15942 D.

Mercury-Vapor Lamps.

Practical Notes on Illumination by Cooper-Hewitt Mercury Lamps. L. Crouch. Remarks on the Heraeus quartz mercury vapor lamp, and the points in which it is superior and inferior to the Cooper-Hewitt, giving costs of installing and operating mercury vapor lamp equipments, etc. 1400 w. Elec Rev, Lond—July 15, 1910. Serial. 1st part. No. 15891 A.

Photometry.

Carbon Filament Lamps as Photometric Standards. E. B. Rosa and G. W. Middlekauff. Describe a recent study made of the performance of carbon filament electric lamps as photometric standards. An account of work of the Bureau of Standards. Ills. 4500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15279 F.

A New Form of Direct-Reading Candle-Power Scale and Recording Device for Precision Photometers. George W. Middlekauff. Describes the new apparatus in use in the United States Bureau of Standards. 3000 w. Elec Wld—July 21, 1910. No. 15827.

The Measurement of Surface-Brightness. J. S. Dow. Illustrates and describes the Dow-Mackinney photometric instrument and its use. 2500 w. Elec Rev, N Y—July 16, 1910. No. 15640.

Street.

Public Lighting from a Municipal Point of View. Jacques Abady. Abstract of a paper read before the Inst. of Gas Engrs. Discusses the relative merits of street lighting contracts in vogue, favoring the buying by light value. Considers the location of lamps, distribution of light and related subjects. 6500 w. Elect'n, Lond—July 8, 1910. No. 15600 A.

MEASUREMENT.

Alternating Current.

Some Recent Developments in Exact Alternating-Current Measurements. Clayton H. Sharp and William W. Crawford. Describes certain new methods and apparatus. Ills. 6500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15280 F.

Galvanometers.

Galvanometer for A. C. Circuits. Dr. W. E. Sumpner and W. C. S. Phillips. Abstract of paper and discussion before the Phys. Soc. of London. Describes a galvanometer by means of which inductances and capacities can be compared by bridge methods as accurately as it is possible to compare resistances. 1500 w. Elec Engr, Lond—July 15, 1910. No. 15889 A.

Hysteresis.

Magnetic Hysteresis. Morton G. Lloyd. Treats of the latest methods of measuring magnetic quality in general and in particular the losses which occur in iron and iron alloys when placed in alternating and rotary magnetic fields. 5500 w. Jour Fr Inst—July, 1910. No. 15846 D.

Insulator Testing.

Mechanical Tests of Insulator Porcelain and Glass. Ralph P. Clarkson. An illustrated report of experimental tests. 1500 w. Elec Wld—July 7, 1910. No. 15482.

Laboratories.

The Arrangement of Experimental Electrical Circuits for Laboratories. W. P. Steinthal. Abstract of paper before the Inst. of Elec. Engrs. Discusses the requirements and describes the arrangement of circuits, and switch and plug boards. Ills. 4500 w. Elect'n, Lond—June 24, 1910. No. 15516 A.

Meters.

Investigating Manufacturing Operations with Graphic Meters. C. W. Drake. On the use of these meters to give continuous records, illustrating by examples. Ills. 2000 w. Elec Jour—July, 1910. No. 15852.

Some Notes on Meters of the Thomson-Houston Type. Paul May. Abstract translation from *Elektrotechnische Zeit.* Notes showing methods of reducing the depreciation of these meters. 1700 w. Elect'n, Lond—July 1, 1910. No. 15524 A.

Motor Testing.

See Dynamometers, under MECHANICAL ENGINEERING, Measurement.

Permeameters.

A Comparison of Magnetic Permeameters. Charles W. Burrows. Reports an investigation made to determine what agreement exists between magnetic data of different experimenters working with different apparatus. 2000 w. Elec Rev, N Y—July 16, 1910. No. 15638.

Transformer Testing.

Indirect Testing of Instrument Transformers by High-Tension Current (Prova indiretta dei Trasformatori di Misura per forti Intensita di Corrente). Angelo Barbagelata. Mathematical discussion of the method. Ills. 2000 w. Monit Tech—June 10, 1910. No. 15750 D.

See also Shop Practice, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Tuning Forks.

The Electric Tuning Fork (Contribution à la Technique de l'Electro-Diapason). A. Guillet. A technical discussion of tuning-fork circuit breakers and their uses. Ills. 6000 w. Tech Mod—June, 1910. No. 15722 D.

Units.

The International Electrical Units 1893-1910. E. B. Rosa. A review of the work that has been done toward establishing international electrical units. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15284 F.

Wheatstone Bridge.

The Design of a Quick-Acting Wheatstone Bridge. Charles R. Underhill. Illustrated description of an instrument which has given great satisfaction for accurate use. 700 w. Elec Wld—July 7, 1910. No. 15484.

POWER APPLICATIONS.

Heating.

Electric Heating and Pyrometry. Abstract of the Tyndall lecture delivered by Prof. J. A. Fleming at the Royal Institution. Discusses methods of electric heating. Ills. 3500 w. Engng—June 10, 1910. No. 15500 A.

TRANSMISSION.

Conduits.

Improvements Suggested in Underground Conduit Construction for Large Transmission Systems. Edw. N. Lake. Suggests improvements with reference to the new ideas of isolation and protection of the cables for which the conduits are built. Ills. 12800 w. Jour W Soc of Engrs—June, 1910. No. 15857 D.

Gas Explosions in an Electric Conduit, New York City. A. A. Breneman. Description and discussion of the cause, showing that a good and continuous system of ventilation is essential. 3500 w. Eng News—July 14, 1910. No. 15592.

Fault Location.

Localization of Faults on Underground Mains. W. A. Toppin. Abstract of paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Describes a simple method of locating earth leakages and the apparatus used. 2500 w. Elect'n, Lond—July 15, 1910. No. 15892 A.

Insulators.

An Experimental Research on Glass and Porcelain Insulators (Ricerche sperimentali sugli Isolatori di Vetro e di Porcellana). Gino Rebora. Reports results of tests. 2500 w. Monit Tech—June 30, 1910. No. 15753 D.

Line Construction.

Construction of 135,000-Volt Transmission into Flint and Battle Creek, Mich. Brief descriptive account of a development on the Au Sable River. 1000 w. Elec Wld—July 14, 1910. No. 15587.

High-Tension Railway Crossings (Kreuzungen von Eisenbahnen durch Hochspannungsleitungen). R. Ulbricht. Discusses mast construction and wire suspension. Ills. 2000 w. Elek Kraft u Bahnen—June 4, 1910. No. 15936 D.

Line Design.

Low Tension Feeder Systems for Street Railways. R. H. Rice. Explains the methods used in calculating the feeders, showing the general results obtained on the street railway systems of Chicago. 4500 w. Jour W Soc of Engrs—June, 1910. No. 15856 D.

Poles.

Poles and Pole Lines. F. L. Rhodes. Read before the N. Eng. Tel. Soc. Considers the most economical pole for use in each section, rates of increase in strength, preservatives, line wire, etc. 4000 w. Can Engr—July 21, 1910. No. 15865.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Substations.

Distribution of Energy in Colorado. Illustrates and describes the substations of the Central Colorado Power Company. 1800 w. Elec Wld—June 30, 1910. No. 15356.

Toronto.

Toronto's Electrical Distribution System. H. C. Barber. Illustrated description of a system using underground distribution in congested sections. 1000 w. Can Elec News—July, 1910. No. 15449.

Transformers.

Determination of Transformer Regulation Under Load Conditions and Some Resulting Investigations. Adolph Shane. Explains a direct method, as well as an accurate calculated method, of checking the results with particular transformers, points out errors in the ordinary method, giving the causes. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15274 F.

Transformers in Three-Phase Circuits. I. Current and Voltage Relations in Open-Delta Connections. R. G. Lafite. II. Current Relations in, and Power-Factor of, an Unbalanced Three-Phase Circuit. R. K. McMaster. Clears up difficult points, and gives simple methods of determining the currents and power-factor. 2000 w. Elec Wld—June 30, 1910. No. 15359.

Voltage Regulation.

Notes on Transmission Line Regulation. P. M. Lincoln. Describes a method of approximating transmission line regulation which has been of use and is sufficiently accurate. 3000 w. Can Engr—July 14, 1910. No. 15637.

MISCELLANY.

Fire Alarms.

Automatic Fire Alarms. Remarks on the conflict of interests between the insurance companies and the public, especially relating to conditions in London. 2500 w. Elec Rev, Lond—July 1, 1910. No. 15515 A.

Inspection.

Report of H. M. Electrical Inspector of Factories. Information from the annual report of G. Scott Ram. Also editorial. Ills. 6500 w. Mech Engr—June 24, 1910. No. 15529 A.

Insulating Materials.

Gutta-Percha and Substitutes. Information concerning the production, manufacture and commercial uses of gutta-percha, balata, jelotong, and other substitutes. 2000 w. Sci Am Sup—July 2, 1910. No. 15404.

Insulating Oils.

Dielectric Strength of Oil. H. W. Tobey. Outlines some of the more important characteristics of oil, with special reference to dielectric strength, giving results of extensive tests. Ills. 5500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15278 F.

INDUSTRIAL ECONOMY.

Depreciation.

Depreciation. George Johnson. Discusses methods of providing for shrinkage in value. 2500 w. Elec Rev, Lond—June 24, 1910. No. 15513 A.

The Ethics of Allowances for Depreciation. L. S. Randolph. Discusses three possible general policies and their physical and financial effects. 1800 w. Engineering Magazine—Aug., 1910. No. 16001 B.

Depreciation and Maintenance Costs in Factory Operation (Abschreibungen und Instandhaltungskosten in Fabrikbetrieben). Jul. H. West. Discusses methods of making depreciation allowances, accounting, etc. 4500 w. Tech u Wirt—June, 1910. No. 15960 D.

Designing.

Cost in Engineering Design. Editorial on the necessity of draughtsmen studying carefully the cost without impairing the efficiency. 1800 w. Engng—July 8, 1910. No. 15675 A.

Education.

Applying an Industrial System for Efficiency in Technical Instruction. S. E. Slocum. Read before the Soc. for the Pro. of Engng Ed. Shows how the Taylor system of shop management may be used effectively in this field. 2000 w. Eng News—July 7, 1910. No. 15411.

Co-operative Engineering Education. Herman Schneider. From a paper read before the Soc. for the Pro. of Engng. Ed. Explains the system of the University of Cincinnati. 3000 w. Ry Age Gaz—July 15, 1910. No. 15613.

Broader View of Industrial Education. Dexter S. Kimball. An expression of the writer's views in regard to the system that promises the best results. 3000 w. Am Mach—Vol. 33. No. 29. No. 15695.

Economic Seminary of the Berlin Technical High School (Das volkwirtschaftliche Seminar der kgl. Technischen Hochschule zu Berlin). C. Walther. Discusses the organization for instruction in economics and sociology. 2200 w. Tech u Wirt—June, 1910. No. 15950 D.

The Danzig Technical High School (Die Technische Hochschule zu Danzig). R. Rossler. A review of its development, courses, methods, equipment, etc. Ills. 12000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15955 D.

Engineering.

The Qualities for Success in Engineering. Dr. Ira N. Hollis. Address before the Class of 1910, Worcester Polytechnic Institute. 6500 w. Jour Worcester Poly Inst—July, 1910. No. 15819 C.

The Engineer's Duty as a Citizen. George W. Melville. Address at the Atlantic City meeting of the A. S. M. E. Calls attention to the improvements due to the engineering profession, their important part in the present life, and their duty to take an active part in everything affecting the common good. 2500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15833 F.

Engineering Commissions.

Special Engineering Commissions. Editorial discussion of commission work and the principles governing it. 2500 w. Eng News—July 21, 1910. No. 15807.

Exhibitions.

The Brussels Universal Exposition, 1908 (L'Exposition universelle de Bruxelles, 23 Avril-October, 1910). L. Ramakers. A general description of the grounds, buildings, and exhibits. Ills. 3000 w. Génie Civil—June 11, 1910. No. 15735 D.

Filing Systems.

Indexing System for Boiler and Plate Metal Shops Covering Blue Prints, Tracings, and Batteries. Edwin E. Rohrer. Describes a convenient method, showing the advantage of system. 1200 w. Boiler Maker—July, 1910. Serial. 1st part. No. 15582.

Germany.

East-German Industry (Die ostdeutsche Industrie). W. John. Discusses the industrial development of the eastern provinces of Germany. 9000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15954 D.

Labor Insurance.

Sickness and Death Rates in the Leipzic and District Sick Fund (Die Krankheits- und Sterblichkeits-Verhältnisse der Krankenkasse für Leipzig und Umgegend). Dr. Bender. Reports causes of illness, distribution among various industries, effects of alcohol, etc. 3500 w. Tech u Wirt—June, 1910. No. 15962 D.

Management.

The Twelve Principles of Efficiency. Harrington Emerson. This third article of a series discusses the first principle—Clearly Defined Ideals. 5500 w. Engineering Magazine—August, 1910. No. 16000 B.

How the Foremen Can Promote Shop Efficiency. C. L. Alden. One of the articles submitted in the competition which closed April 15. Deals mostly with the proper treatment of employees. 1200 w. Ry Age Gaz—July 1, 1910. No. 15362.

Overhead Charges and Shop Output. Holden A. Evans. Notes on good shop management with particular reference to its relation to overhead expenses. 3000 w. Am Mach—Vol. 33. No. 30. No. 16011.

Costs of Machine-Tool Operations in Steam-Engine. Manufacturing. William O. Webber. Gives facts showing reductions due to efficiency methods. 2000 w. Engineering Magazine—August, 1910. No. 16004 B.

Paraguay.

Paraguay (Mededeelingen over Paraguay). M. J. de Bosch Kemper. Discusses political and industrial conditions. 6500 w. De Ingenieur—June 18, 1910. No. 15965 D.

Patents.

The Status of Alloys under the Patent Law (Ueber die patentrechtliche Stellung der Legierungen). Victor Samter. Discusses the situation in Germany. Serial. 1st part. 1500 w. Giesserei-Zeit—June 1, 1910. No. 15780 D.

Profit Sharing.

New System of Profit Sharing (Nouvelle Forme de la Participation des Travailleurs aux Bénéfices industriels). Sylvain Périssé. Suggests a system for general use in France and gives results of its operation in six establishments. 5000 w. Génie Civil—June 4, 1910. No. 15732 D.

Strikes.

The Right to Strike: Its Limitations. Joseph J. Feely. From an article in the *N. Am. Rev.* An interesting discussion of strikes that involve the public welfare. 2500 w. Ry Age Gaz—July 29, 1910. No. 16042.

Trade Secrets.

Trade Secrets in the Electrochemical Industry (Technische und Herstellungsgeheimnisse in der elektrochemischen Industrie). Discusses their nature and importance and the new German law for their protection. Serial. 1st part. 1500 w. Elektrochem Zeitschr—June, 1910. No. 15761 D.

Trusts.

A Comparison of the American Iron and Coal Trusts with the German Kartel System (Comparaison du Système des Trusts americains dans l'Industrie du Fer et de la Houille avec Système allemand des Syndicats ou Kartelle). M. Pilz. Abstracted from *Glückauf.* 11500 w. Rev de Métal—June, 1910. No. 15713 E + F.

Wage Systems.

Wage Systems in American Railway Shops with Special Reference to the Santa Fe Bonus System (Das Lohnwesen in amerikanischen Eisenbahnwerkstätten, unter besonderer Berücksichtigung des Bonus-Lohnsystems der Santa Fe-Bahn). Bruno Schwarze. The first part discusses the systems of the B. & O. and the Pennsylvania. Forms. Ills. Serial. 1st part. 4000 w. Glasers Ann—June 1, 1910. No. 15921 D.

See also same title, under CIVIL ENGINEERING, Construction.

Workmen's Houses.

The Ninth International Small-Habitations Congress, Vienna, 1910 (Le IX^e Congrès international des Habitations à bon Marché, Vienne, May-June, 1910). Maurice Bellom. A report of the proceedings of the Congress, dealing with the housing of workmen. 3000 w. Génie Civil—June 18, 1910. No. 15738 D.

MARINE AND NAVAL ENGINEERING.

Battleships.

The First Dreadnought. Letter from William Boerum Wetmore, giving information and illustration of the ironclad "Onondaga," authorized by the U. S. Congress in 1861. 800 w. Sci Am—July 23, 1910. No. 15808.

German Battleships. Photographs and information concerning four battleships of the Dreadnought type now completed for the German Navy. 1000 w. Engng—June 10, 1910. No. 15499 A.

British Navy.

Progress of Warships and Machinery Under Construction in England. Half-yearly report of progress in Great Britain. 2500 w. Engr, Lond—July 1, 1910. No. 15564 A.

Cruisers.

Ninety-four-Foot Cruiser. Plans and description. 1200 w. Rudder—July, 1910. No. 15352 C.

Davits.

Quadrant Davit for Double-Banked Boats. Illustrated description of a new design of the Welin quadrant davit. 1000 w. Engng—July 1, 1910. No. 15543 A.

Destroyers.

The Latest Turbine Destroyers of the French Navy. Illustrated article giving the main particulars of these vessels, and describing details. Also reporting the results of the different modes of propulsion. 3000 w. Int Marine Engng—July, 1910. No. 15367 C.

Torpedo-Boat Destroyer *Voltigeur* (Torpedojäger "Voltigeur"). Describes and gives performance of the recent additions to the French Navy. 4000 w. Schiffbau—June 8, 1910. No. 15901 D.

Electric Power.

Electricity on Shipboard. J. M. Heslop. Abstract of a lecture delivered before the Engineering Society of the Technical College of Sunderland dealing with special applications. 4000 w. Cassier's Mag—July, 1910. No. 15650 B.

Regulation in Electrical Propulsion (Reguliermethoden fur den elektrischen Propellerantrieb). Alex. Simon. Describes methods of regulating propeller speed. Ills. 2000 w. Schiffbau—June 22, 1910. No. 15904 D.

Floating Cranes.

The Development of Floating Cranes (Die Entwicklung der Schwimmkrane). Herr Wintermeyer. Describes various types. Ills. 4500 w. Schiffbau—June 8, 1910. No. 15900 D.

Hydroplanes.

The Skimming Boat. Illustrated detailed description of the Miranda IV, a motor boat built by John I. Thornycroft & Co., Ltd. 1000 w. Engr, Lond—July 15, 1910. No. 15977 A.

Internal-Combustion Engines.

Internal-Combustion Engines for Marine Use. W. R. Cummins. Read before the Inst. of Marine Engrs., at the Japan-British Exhibition. An outline of the writer's ideas concerning internal-combustion plants for marine work. 4800 w. Mech Engr—July 1, 1910. No. 15531 A.

Marine Gas Engines. Gives rules for the survey of internal-combustion engines for marine purposes, drawn up by Lloyd's Register. 1000 w. Engr, Lond—June 24, 1910. No. 15554 A.

Model Cutting.

Machine for Cutting Wax Ship-Models at the National Physical Laboratory. Illustrated description of the apparatus installed for the manufacture of the wax models used for tests. 1800 w. Engng—July 8, 1910. No. 15677 A.

Oil Engines.

180-Brake-Horse-Power Reversible Marine Oil-Engine. Illustrated description of an engine of the 4-cylinder type, each cylinder being 12 ins. in diameter. 700 w. Engng—July 8, 1910. No. 15673 A.

Propellers.

Speed Propeller Wheels. Harry J. Perkins. An explanatory article on the design, construction and selection of proper wheels. 3000 w. Rudder—July, 1910. No. 15351 C.

Ship Propulsion by Radial Reaction Propellers (Antrieb von Schiffen mittels radialen Reaktionspropellers). Felix Langen. Mathematical. 3500 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1910. No. 15912 D.

Propulsion.

The Propulsion of Cargo-Boats. R. M. Neilson. A comparative study of the best modern system of propulsion in view of recent engineering developments. Ills. 11000 w. Cassier's Mag—July, 1910. No. 15648 B.

Shipbuilding.

Shipbuilding Estimates. J. A. Pearson. Read before the Greenock Assn. of Engrs. & Ship Bldrs. Discusses the making of estimates, considering material, wages, purchases, and establishment charges. 2500 w. Mech Wld—July 15, 1910. Serial. 1st part. No. 15807 A.

Reduction in Cost of Navy Yard Work. Holden A. Evans. Explains how scientific management resulted in reductions in cost. 4000 w. Am Mach—Vol. 33. No. 26. No. 15338.

The Schichau Works in Elbing, Danzig and Pillau (Die Schichau-Werke in Elbing, Danzig and Pillau). Describes the development of these German shipyards. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15956 D.

Ship Stability.

Calculation of the Transverse Stability of Ships (Beitrag zur Berechnung der Querstabilität von Schiffen). Jul. Ott. Detailed demonstration of the method. Ills. Serial. 1st part. 5000 w. Schiffbau—June 22, 1910. No. 15903 D.

Spanish Navy.

The New Spanish Navy. Briefly reviews the scheme for building a modern fleet and reconstructing the naval arsenals, and gives illustrated descriptions of three new battleships. 3000 w. Engng—July 15, 1910. No. 15971 A.

Steamboats.

San Francisco Bay Steamer Napa Valley. A vessel for passenger and excursion traffic is illustrated and described. 1200 w. Marine Rev—July, 1910. No. 15603.

Steam Engines.

Economical Operation of Marine Engines (Sull' Economia di Esercizio delle Macchine a Vapore Marine). Benvenuto Rossi. Deals principally with problems of lubrication. Ills. 5000 w. Riv Marit—June, 1910. No. 15745 E + F.

Steamships.

Passenger and Freight Steamships City of Montgomery and City of St. Louis. Illustrates and describes the two latest vessels for the New York-Savannah service. 3500 w. Int Marine Engng—July, 1910. No. 15368 C.

The White Star Line. A review of the development of this important steamship line, illustrating notable vessels, and describing their construction and equipment. Plates. 12000 w. Engr, Lond (Sup)—June 24, 1910. No. 15555 A.

The "Jan Breydel" and "Pieter de Coninck" on the Ostend-Dover Service. Illustrated detailed description of new turbine vessels for cross-channel service. Plate. 3500 w. Engng—July 15, 1910. No. 15973 A.

Four New Twin-Screw Steamers for the Nippon Yusen Kaisha European Line. An illustrated article giving particulars of the Kamo-Maru, Hirano-Maru, Atsuta-Maru, and Kitano-Maru, built in Japan. 3500 w. Int Marine Engng—July, 1910. No. 15366 C.

Submarines.

A New Type of Submarine Boat. Brief illustrated description of Bayer's duplex boat. 600 w. Sci Am Sup—July 9, 1910. No. 15416.

Ballast and Diving Arrangements in Submarine Design (Ballast- und Taucheinrichtungen für ein Unterseeboot-Rohprojekt). Karl Dietze. A discussion of the design of submarines. Ills. 2000 w. Schiffbau—June 22, 1910. No. 15902 D.

Survey Vessels.

Survey Steamship for Canada. Illustrated description of the "Cartier," a new twin-screw survey steamer for the Canadian Government. 700 w. Engr, Lond—June 24, 1910. No. 15549 A.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Ball Bearings.

Loads on Ball Bearings in Gear Transmissions. J. Dornacher. Trans. from *Der Motorwagen.* An examination of ball bearing loads at the different gear speeds in a number of automobiles, with disregard of friction losses. 2000 w. Automobile—July 28, 1910. No. 16039.

Loads on Automobile Ball Bearings (Belastung von Kugellagern in Automobilgetrieben). J. Dornacher. Gives tables showing loads at various speeds in cars of many makers. Ills. Serial. 1st part. 2500 w. Motorwagen—June 10, 1910. No. 15917 D.

Clutches.

See same title, under MACHINE ELEMENTS AND DESIGN.

Commercial Vehicles.

Gasoline-Electric Truck for Haulage in Arid Regions. W. D. Hornaday. Describes an interesting transportation line between Marathon, Tex., and a point on the Rio Grande 80 miles south, explaining the conditions and illustrating the vehicle. 1000 w. Elec Wld—July 21, 1910. No. 15829.

Construction.

Economy in Materials in Automobile Construction (Wirtschaftliche Materialdifferenzierung im Automobilbau). N.

Stern. Discusses the use of special steels, etc., Serial. 1st part. 1500 w. Motorwagen—June 30, 1910. No. 15918 D.

Control.

A New "Gate-Change" with Ever-Meshing Gears. Illustrated description of the latest Adams development in pedal operation of gears. 1500 w. Auto Jour—June 25, 1910. No. 15509 A.

Electric.

Progress in Electric Vehicles (Neuerungen im elektrischen Kraftwagenbetrieb). W. Wolf. The first part describes recent types of motors. Ills. Serial. 1st part. 1200 w. Motorwagen—June 30, 1910. No. 15919 D.

Fire Apparatus.

Modern Automobile Fire Apparatus (Moderne Feuerwehrautomobile). Describes various types and makes of fire apparatus. Ills. Serial. 1st part. 4000 w. Zeitschr d Mit Motorwagen Ver—June 30, 1910. No. 15916 D.

Fuels.

Conservation Idea in Its Application to Motoring. Albert L. Clough. Discusses the subject as applied to liquid fuels, their waste, production, etc. 2200 w. Horseless Age—June 29, 1910. No. 15311.

Fuel and Oil for Motor Cars. J. Veitch Wilson. Excerpts from a paper read before the Coventry Engng. Soc. Deals with the petroleum industry, oil refinement, economical methods, etc. 3000 w. Auto Jour—July 2, 1910. Serial. 1st part. No. 15510 A.

Some Points Worth Knowing About Automobile Gasoline. Shows that automobile gasoline is but slightly related to technical gasoline, and discusses temperature, efficiency of combustion, and the excess of air needed. 1600 w. Automobile—July 21, 1910. No. 15822.

Alcohol and the External Combustion Engine. William D. Ennis. Discusses alcohol as a fuel and the binary vapor principle. Compares the characteristics of various fuels. 2500 w. Automobile—July 28, 1910. No. 16037.

Fuel Tanks.

Studies Involving Refinements of Gasoline Equipment. Points out that the filler car for the gasoline tank should be made so that it will hold pressure; and that gasoline will not flow through a fine wire mesh if it is first wetted by water. Ills. 2200 w. Automobile—June 30, 1910. No. 15313.

Hotchkiss.

The 12-16 H. P. Hotchkiss. Illustrates and describes a departure from usual practice in the clutch design. 1000 w. Autocar—July 9, 1910. No. 15658 A.

Ignition.

High Potential Test on Porcelain Spark Plugs. Tests were made to ascertain the dielectric strength of the porcelain used under the conditions fixed in spark plug. 1200 w. Automobile—June 30, 1910. No. 15314.

Action of the Inductor Magneto. F. P. McDermott, Jr. Reviews fundamental principles of electricity and magnetism, and discusses the magneto. Ills. 2800 w. Horseless Age—July 13, 1910. No. 15645.

The Gibaud Magneto. Brief illustrated description. 700 w. Autocar—July 9, 1910. No. 15657 A.

Legislation.

Callan Law Takes Effect in New York August 1, 1910. Gives full text of a new statute regulating the use of motor vehicles on public highways. 7800 w. Com Veh—July, 1910. No. 15299 C.

Military.

The Employment of Mechanical Transport for Military Purposes. H. R. Hayter. Describes various types of vehicles in use, discussing the advantages and disadvantages of steam and internal-combustion engines, and related matters. 9000 w. Jour Roy U S Inst—June, 1910. No. 15287 N.

Motor Efficiency.

The Prediction of Efficiency in Internal Combustion Engines. William D. Ennis. Gives a theoretical estimate with formulae, discussing the importance of a proper mixture and the economy of a wide-open throttle. 2000 w. Automobile—July 28, 1910. No. 16036.

Motor Heating.

An Unlooked-For Reason for Overheating Motors. Thomas J. Fay. Discusses overheating problems of motors, calling attention to the ills of internal incrustation. The spheroidal condition of the water is considered and its effects. 1200 w. Automobile—July 14, 1910. No. 15699.

Motor Incrustation.

Is Cylinder Incrustation Due to Oil or Gasoline Mainly? Albert L. Clough. Aims to open a discussion of the cause of these incrustations, and the part the carburetor may play as the source of the evil. 1800 w. Horseless Age—July 13, 1910. No. 15644.

Motor Location.

Motor-in-Front vs. Motor-Under-Seat Construction. A comparative discussion of the two types, taken from a recent article in a London paper. 2000 w. Com Veh—July, 1910. No. 15300 C.

Motors.

Modern Automobile Practice. First of a series of articles on petrol-driven vehicles with special reference to transmission. The present number reviews leading characteristics of the engine. Ills. 2000 w. Prac Engr—July 8, 1910. Serial. 1st part. No. 15663 A.

Omnibuses.

Daimler 'Bus with Twin Power Plants. James W. Richardson. Illustrated description of a novel public service vehicle equipped with gasoline-electric power units in duplicate. 2000 w. Com Veh—July, 1910. No. 15298 C.

A New Petrol Electric Omnibus. Illustrated description of a new omnibus built by the Daimler Co. 1200 w. Engr, Lond—June 24, 1910. No. 15550 A.

Owen.

Owen Cars with Big Wheels and Left-Hand Drive. Illustrated detailed description. 1200 w. Automobile—July 7, 1910. No. 15419.

Springs.

Some Notes on Good Spring Suspensions. David Landau and Asher Golden. Discusses questions relating to vehicle suspension, giving notes and data of good suspensions. 2000 w. Horseless Age—July 20, 1910. No. 15866.

Tire Repairs.

The Automobile Tire Repair Business S. M. Howell. Drawings and suggestions for the work. 3000 w. Horseless Age—July 20, 1910. No. 15867.

Transmissions.

Efficiency of Friction Transmission. Benjamin F. Bailey. Gives results obtained by mathematical calculation. 2200 w. Horseless Age—July 6, 1910. No. 15491.

Valveless.

The 25 H. P. Valveless Car. Illustrated description of this car which has undergone considerable alteration in the design of both engine and chassis. 1000 w. Autocar—June 25, 1910. No. 15506 A.

Vulcan.

The 15.9 H. P. Vulcan Car. Illustrated description of a new model. 1500 w. Autocar—July 2, 1910. No. 15507 A.

Wind Screens.

A Few Facts on Wind-Screen Efficacy. Diagrams and descriptions of experiments. 2000 w. Auto Jour—July 16, 1910. No. 15887 A.

Some Typical Wind-Screen Designs and Their Respective Merits. Illustrations and explanatory comments. 3000 w. Auto Jour—July 9, 1910. No. 15656 A.

COMBUSTION MOTORS.

Aeronautic Motors.

The Arrangement of Valves in Aeroplane Engines. Considers the conditions to be satisfied in a perfect valve arrangement for these engines. Ills. 2200 w. Engng—June 10, 1910. No. 15496 A.

Some Recent Light Aeroplane Engines. Roy Lindsay. Illustrates and describes types. 3000 w. Horseless Age—July 13, 1910. No. 15646.

Some Light Weight Motors from Europe. Illustrated descriptions. 3000 w. Automobile—July 28, 1910. No. 16040.

Aeronautic Motors and an Aerial Cruiser (Moteurs aéronautiques et Croiseur aérien). J. A. Farcot. Describes a new motor and dirigible developed by the author. Ills. 1800 w. Bul Soc d'Encour—May, 1910. No. 15714 G.

Gas-Engine Cycles.

A Regenerator Cycle for Gas Engines Using Sub-Adiabatic Expansion. A. J. Frith. Describes these regenerative cycles and discusses defects, and calls attention to a new regenerator cycle with sub-adiabatic expansion which promises unusual results. Ills. 4500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15840 F.

Gas-Engine Indicators.

The Okill Pressure Indicator. Illustrated description of an indicator for ascertaining the pressures in the cylinders of gas-engines. 1000 w. Mech Engr—June 24, 1910. No. 15535 A.

Gas Engines.

The Ruston-Proctor Engines at the Brussels Exhibition. Describes some of these semi-portable engines, illustrating two of them. 1000 w. Engng—July 1, 1910. No. 15544 A.

Portable Suction Gas Engine. Illustrates and describes an 18 B. H. P. portable suction gas engine, stating the advantages claimed over the steam engine. 600 w. Engr, Lond—July 15, 1910. No. 15979 A.

Gas Engines and Gas Producers (Les Moteurs à Gaz et les Gazogènes à Gaz pauvre). M. Letombe. A general review of their construction and applications. Ills. 10000 w. Tech Mod—June, 1910. (Sup.) No. 15721 D.

See also Engines, under MECHANICAL ENGINEERING, Steam Engineering.

Gas Power Plants.

Pipe Lines, Etc., for Gas Engines. Gives a few empirical formulae for the diameters of various pipe lines in gas-engine installations for meter capacities and gas-bag dimensions and general rules. 1500 w. Mech Wld—June 24, 1910. No. 15534 A.

See also Blast-Furnace Gas, under MINING AND METALLURGY, Iron and Steel.

Gas Producers.

The Akerlund Bituminous Gas Producer. Illlustrated detailed description of a suction down-draft, grateless generator and novel cleaning apparatus. 1200 w. Ir Age—July 7, 1910. No. 15308.

Gas Producers (Ueber Gaserzeuger). J. Hofmann. Read at the Düsseldorf Congress. A review of their development and a description of types now in use. Ills. 7500 w. Stahl u Eisen—June 15, 1910. No. 15771 D.

See also Gas Engines, under Combustion Motors.

Gas Turbines.

The Cooling of Gas Turbines (Ueber die Kühlung von Gasturbinen). W. Gentsch. Illustrates a number of cooling devices and methods. 5000 w. Die Turbine—June 20, 1910. No. 15910 D.

Ignition.

Ignition in Gas and Gasolene Engines. Carl Pfanstiehl. A study of the jump spark. 2500 w. Naut Gaz—July 14, 1910. Serial. 1st part. No. 15618.

Dry Batteries. H. S. Green. Read before the Nat. Gas & Gasoline Eng. Trds. Association. Brief discussion of the care of cells and wiring, method of making connections, rate of discharge, and time allowed for recuperation. 1700 w. Naut Gaz—July 14, 1910. No. 15616.

Oil Engines.

Some Test Figures from an Oil Engine. F. J. Kean. Abstract of a paper read before the Inst. of Marine Engrs., at the Japan-British Exhibition. Gives results of tests with conclusions. 1400 w. Mech Engr—July 1, 1910. No. 15532 A.

Test of a 170-H. P. Oil Engine. H. P. Macdonald. Gives data obtained from the operation of an engine in Jersey City, N. J. Ills. 1000 w. Elec Wld—June 30, 1910. No. 15358.

Producer Gas.

Producer Gas Power. L. F. Burger. Read before the Nat. Gas & Gasoline Eng. Trds. Assn. Explains what producer gas is, and briefly reviews it's use for power. 1800 w. Naut Gaz—July 14, 1910. No. 15617.

HEATING AND COOLING.

Air Humidifying.

Humidity, Its Necessity and Benefits. W. W. Brand. Remarks on the need of educating the public, the effect of dry air in rooms, etc. Discussion. 3500 w. Heat & Vent Mag—July, 1910. No. 15813.

Air Conditioning Apparatus, It's Construction and Application. W. H. Carrier. Illustrates and describes types of air washers, humidifiers, etc., for controlling the condition of the air in shops, mines, etc. General discussion. 8000 w. Pro Engrs' Soc of W Penn—July, 1910. No. 15988 D.

Central Plants.

Central Station Steam Heating. A. D. Spencer. Abstract of a paper read before Nat. Dist. Heat. Assn. Description and operating cost details of a live-steam central station heating system and an exhaust-steam central station heating system in Detroit, Mich. 2000 w. Power—July 5, 1910. No. 15323.

Fans.

See Turbines, under STEAM ENGINEERING; and Ventilation, under MINING AND METALLURGY, MINING.

Federal Buildings.

Heating and Ventilation of Federal Buildings. Nelson S. Thompson. Read before the Am. Soc. of Heat. & Vent. Engrs. Statement of method of choosing type of system and proportioning parts. 1500 w. Met Work—July 16, 1910. Serial. 1st part. No. 15580.

Hot-Air Heating.

Warm-Air Heating Analyzed. R. S. Thompson. Explanation of fundamental ideas of furnace heating, discussing details. 3000 w. Met Work—July 16, 1910. Serial. 1st part. No. 15579.

Refrigeration.

The Cycle of Refrigeration. J. R. Wharton. A study of the cycle in the pressure-volume diagram, also in the temperature-entropy diagram. 7800 w. Ice & Refrig—July, 1910. No. 15290 C.

Steam Heating.

Air-Venting Steam Heating Systems. Charles L. Hubbard. Discusses the location of air valves for the satisfactory removal of air. Ills. 1000 w. Met Work—July 9, 1910. No. 15445.

Ventilation.

The Ventilation of Dwellings (Die Durchlüftbarkeit der Wohnungen). Siegfried Sitte. Discusses the arrangement and construction of dwellings with a view to ventilation requirements. Ills. 3000 w. Zeit d Oest Ing u Arch Ver—June 10, 1910. No. 15926 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

De Laval High Efficiency Centrifugal Pumps. Illustrated article considering the principles of design and their selection for various services. 3500 w. Ir Age—July 7, 1910. No. 15306.

Messrs. Gebr, Stork & Co.'s Exhibits at the Brussels Exhibition. Illustrated description of a five-stage high-pressure electrically-driven centrifugal pump for mine drainage. 800 w. Engng—July 15, 1910. No. 15972 A.

New Pumps of the Pontaniou Graving Dock at the Brest Arsenal (Nouvelles Pompes d'Epuisement des Formes de Radoub de Pontaniou à l'Arsenal de Brest). Describes an installation of three Rateau pumps. Ills. 2000 w. Génie Civil—June 11, 1910. No. 15736 D.

See also Turbines, under STEAM ENGINEERING.

Electric Pumping.

Electricity in Irrigation. Illlustrated description of the electric irrigation pumping plant of the Mosida Fruit Lands Co. in Utah. 1800 w. Elec Wld—July 21, 1910. No. 15826.

Electric Pumping for Irrigation. Alton D. Adams. Explains the necessity of pumping water for irrigating many sections, and illustrates the three ways that electric pumping is applied. 2000 w. Elec Wld—June 30, 1910. No. 15357.

Electric Pumping in California. Alton D. Adams. A report of the extensive use of the electric system in pumping for irrigation. 1500 w. Elec Wld—July 28, 1910. No. 16021.

Electric Pumping in Holland. Illustrates and describes methods adopted in reclamation work at the Maas Estuary. 1000 w. Elec Rev, N Y—July 9, 1910. No. 15487.

Presses.

See Forging Presses, under MACHINE WORKS AND FOUNDRIES.

Rams.

Hydraulic Rams and Their Capacity. N. A. Carle. Charts for calculating the efficiency of rams with explanation of their use. 1000 w. Power—July 5, 1910. No. 15324.

Turbines.

Hydraulic Turbines for 670-Foot Head. H. Birchard Taylor. Illustrated description of two hydraulic reaction turbines for Mexico. 3000 w. Power—July 5, 1910. No. 15321.

Turbine Tests.

Acceptance Tests on Two Turbines Built by A. Riva & Co., Milan (Esperienze di Collaudo su due Turbine a Spirale della Casa Ing. A. Riva & C.—Milano). G. Ghersina. Describes the installation and the tests and gives results. Ills. Serial. 1st part. 1000 w. Industria —June 19, 1910. No. 15757 D.

Water Hammer.

Water Hammer in Conduits (Les Coups de Bélier dans les Conduites d'Eau). A. Rateau. A mathematical discussion of its causes and effects. Ills. 7500 w. All Indus—June, 1910. No. 15727 D.

Water Wheels.

The Efficiency of Water-Wheels. Henry D. Jackson. Explains how the unusually high efficiencies given by builders are obtained, with suggestions for making efficiency tests. 1800 w. Power—July 26, 1910. No. 15982.

MACHINE ELEMENTS AND DESIGN.

Annular Rings.

Deformations of Elastic Rings (Déformations d'un Cercle élastique). M. Bonneau. A mathematical discussion of the deformations of rings under radial stress. Ills. 4000 w. Ann d Ponts et Chaussées —1910—III. No. 15744 E + F.

Bearings.

An Unusual Roller Thrust Bearing. T. F. Salter. Illustrated description of a large thrust bearing for a steel mill, providing roller surfaces for 2,250,000 pounds load. 10000 w. Am Mach—Vol. 33. No. 28. No. 15585.

Clutches.

Some Points Regarding Disc Clutches. F. E. Watts. Brief illustrated description of the elementary principles of the disc clutch. 2500 w. Horseless Age— June 29, 1910. No. 15310.

Conversion Formulae.

Standardized Formulae for Ready Reference. Thomas J. Fay. Deals with simplified conversion formulae. 1500 w. Automobile—July 28, 1910. No. 16038.

Drawings.

New Method for Base Line Drawings. H. E. Goldberg. Explains the weaknesses of present methods, and the development of a new method. Ills. 3000 w. Am Mach—Vol. 33. No. 30. No. 16010.

Filing Systems.

See same title, under INDUSTRIAL ECONOMY.

Gears.

Spiral Gear Problem Solutions. A. E. Thayer. Gives mathematical solutions not generally well known with natural functions of angles, secants, and co-secants. 3500 w. Am Mach—Vol. 33. No. 29. No. 15699.

Gyroscope.

Elementary Theory of the Gyroscope. E. H. Barton. Treats a simple fundamental case of gyroscopic motion, employing only the elementary conceptions of mechanics and the calculus. 1200 w. Engng—June 24, 1910. No. 15537 A.

See also Monorail, under STREET AND ELECTRIC RAILWAYS.

Punch Frames.

Properties and Sections for Punch and Shear Frames. Alton L. Smith. Tables and explanation of a method of simplifying the work of selecting proper sections for punch and shear frames. 800 w. Mach, N Y—July, 1910. No. 15379 C.

Springs.

The Design of Flat Spiral Springs. L. J. Butzow. An exposition of the principles entering into the calculation of this class of springs, giving the most important equations deduced. 1200 w. Mach, N Y —July, 1910. No. 15370 C.

MACHINE WORKS AND FOUNDRIES.

Bending Machines.

Bending Machine for 80-Millimetre Angle Iron (Machine zum Biegen von Winkeleisen bis 80 x 80 mm. Schenkellänge). Franz Brzoska. Describes in detail a machine built by the author at Ratibor, Germany. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—June 23, 1910. No. 15941 D.

Blacksmith Shops.

A Large Blacksmith Shop Using Oil Fuel Exclusively. Holden A. Evans. Describes the smith shop at the Mare Island navy yard and its liquid fuel equipment. Ills. 5000 w. Ir Trd Rev—July 14, 1910. Serial. 1st part. No. 15607.

Boiler Making.

Practical Notes on Boilermaking. J. E. Lawrence. Notes for those engaged in boiler construction and design, arranged mainly in the order in which the operations take place. Ills. 2500 w. Mech Wld—June 24, 1910. Serial. 1st part. No. 15533 A.

Boring Machines.

Primitive Boring Machines. Joseph G. Horner. Drawings and description of a machine shown in a French encyclopedia (1777), for boring a cannon. 600 w. Mach, N Y—July, 1910. No. 15374 C.

The Rochester Horizontal Boring Machine. Illustrates and describes a new standard tool for horizontal boring, drilling, tapping and milling. 1500 w. Ir Age—June 30, 1910. No. 15302.

Brass Founding.

The Production of the "Heat-Black Finish" on Brass, Bronze and Copper. Gives the solutions, method of applying and final treatment. 1000 w. Brass Wld—July, 1910. No. 15687.

Fluxes Used in the Brass Foundry. Irwin S. Sperry. Read before the Am. Brass Found. Assn. Describes fluxes that have proved valuable for aluminum, nickel, copper, brass, bronze or composition, German silver, etc., and the manner in which they should be used. 3000 w. Am Mach—Vol. 33. No. 27. No. 15441.

Can-Making Machines.

Automatic Can Making Machinery. Illustrated descriptions of machines for automatically forming, seaming, soldering, heading and hemming. Also a testing machine to discover leaks. 2000 w. Am Mach—Vol. 33. No. 27. No. 15437.

Castings.

The Shrinkage of Cast Iron (Ueber das Schwinden des Gusseisens). H. Vetter. Discusses it's causes and effects, methods of making allowances for it, etc. 2500 w. Stahl u Eisen—June 1, 1910. No. 15766 D.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Chip Briquetting.

Briquetting Iron and Steel Chips. Hubert Hermans. Describes a process developed in Germany for utilizing chips. 2200 w. Am Mach—Vol. 33. No. 27. No. 15439.

Coil Winder.

Winding Flat Copper Strip Coils. Illustrated description of a device for winding electric coils of flat strip copper. 1200 w. Am Mach. Vol. 33. No. 29. No. 15698.

Cores.

Tinned Core Supports and Some Tests with Supports Containing Lead (Ueber den Begriff "handelsublich verzinnte Kernstützen" und einige Versuche mit bleihaltigen Kernstützen). F. Westhoff. A brief discussion of the cost of core-support materials. Discussion. Ills. 2000 w. Stahl u Eisen—June 1, 1910. No. 15765 D.

Cupola Practice.

A Substitute for Pine Wood in Starting Cupolas (Die Frage eines Ersatzes von Kiefernscheitholz zum Anheizen der Kupolofen). O. Henning. Suggests the use of an oil or gas flame for igniting the coke. Discussion. Ills. 2000 w. Stahl u Eisen—June 1, 1910. No. 15764 D.

The Removal of Difficulties in Tapping Cupolas (Ueber den Kupolofen-Abstich und seine Beseitigung). Describes a tipping fore-hearth, its advantages and operation. Ills. 1300 w. Giesserei-Zeit—June 1, 1910. No. 15781 D.

Dies.

Operation and Construction of the Sub-Press Die. Roy Plaisted. Illustrated description. 1500 w. Mach, N Y—July, 1910. No. 15380 C.

Drilling.

Drill Press Work on Screw Machine. S. H. Bacon. Describes a method of performing cross-drilling operations on a special piece of work with the spindle controlled in an unusual manner. Ills. 800 w. Am Mach—Vol. 33. No. 27. No. 15435.

Drilling Machines.

High Power Drilling Machines. Illustrates and describes a machine designed for high duty and rapid work, reporting tests. 1000 w. Am Mach—Vol. 33. No. 26. No. 15336.

Enamelling.

The Constituents of Enamelling Glaze and Their Properties (Die Hauptbestandteile der Emailleglasur und deren Eigenschaften). J. Schlemmer. Practical notes on the materials used in enamelling. Serial. 1st part. 1400 w. Giesserei-Zeit—June 1, 1910. No. 15782 D.

Forging.

A Few Forging Operations. Ethan Viall. The practice in the C., H. & D. R. R. shop, Lima, Ohio, is illustrated and described. 700 w. Mach, N Y—July, 1910. No. 15378 C.

Forging Presses.

The Hydraulic High-Speed Forging Press. Illustrated description of the Davy forging press, as manufactured at Pittsburg. 2500 w. Ir Trd Rev—July 21, 1910. No. 15821.

A High Speed Hydraulic Forging Press. Illustrated description of the type built by the United Engineering & Foundry Co. 1200 w. Ir Age—June 30, 1910. No. 15303.

Foundries.

Foundry for Casting Transformers. Illustrates and describes methods and apparatus used in the new foundry of the General Electric Company, at Pittsfield, Mass. 1200 w. Am Mach—Vol. 33. No. 30. No. 16007.

Foundry Coke.

Coke for Foundry Purposes. E. L. Rhead. Read before the British Found. Assn. Discusses conditions affecting the quality of the coke, and related subjects. 3000 w. Engng—July 15, 1910. No. 15975 A.

Foundry Furnaces.

The Construction of Crucible Furnaces. Walter J. May. An illustrated article giving detailed directions for the construction of such furnaces. 2500 w. Mech Wld—July 8, 1910. No. 15668 A.

Galvanizing.

A New Process (Spray Process) for the Production of Metallic Coatings. M. U. Schoop. Describes this new process; the essential features are that metal in liquid and highly heated condition is sprayed onto the surface to be coated. 2300 w. Met & Chem Engng—July, 1910. No. 15420 C.

Gear Cutting.

Determining Dimensions of Gears from Samples. E. Winslow Baxter. Explains methods of duplicating worn out or broken gears. 800 w. Mach, N Y—July, 1910. No. 15373 C.

Machining Bevel Pinion Blanks. C. L. Goodrich. The bevel surfaces are machined to the correct angle by means of an angular turning fixture carried by the turret. Ills. 800 w. Am Mach—Vol. 33. No. 30. No. 16008.

Punch and Die for Elliptic Gears. W. J. McDevitt. Describes the method of calculating laying out and making the punch and die for this work. 800 w. Mach, N Y—July, 1910. No. 15372 C.

Large Double-Headed Gear-Cutting Machine. Illustrated description of a machine for cutting large double helical gears. 700 w. Engr, Lond—July 8, 1910. No. 15684 A.

Grinding.

Grinding Economy. H. Darbyshire. A criticism of a statement in Mr. Thacher's article on "Economy in Grinding," and a discussion of the economic side of the grinding question. 2500 w. Mach, N Y—July, 1910. No. 15381 C.

Grinding Machines.

History of the Invention of the Universal Grinding Machine. Luther D. Burlingame. An illustrated account of its development from the crude grinding lathe used in the early 60's. 1500 w. Mach, N Y—July, 1910. No. 15369 C.

The Thompson Universal Grinder. Illustrated description of a machine for all kinds of grinding. 1000 w. Ir Age—June 30, 1910. No. 15301.

Lathes.

Cone vs. Geared Drive. R. K. LeBlond. Read before the Nat. Machine Tool Blds' Convention. An examination of the efficiency of the two methods and the advantages of each. 2500 w. Mach, N Y—July, 1910. No. 15377 C.

Modern Car-Wheel Turning. Walter L. Clark. Illustrates and describes improved wheel lathes, and the large output made possible. 2000 w. Cassier's Mag—July, 1910. No. 15647 B.

Pond Car Wheel Lathe with Pneumatic Attachments. Illustrated description. 700 w. Mach (Ry. Ed.)—July, 1910. No. 15384 C.

Machine Tools.

See Management, under MACHINE WORKS AND FOUNDRIES.

Molding.

Cylinder Moulding for Railway Engines. H. Pemberton. Read before the Birmingham branch of the British Found. Assn. Illustrated description of methods used for the three types in most common use on the Midland Ry., the twin cylinders, the piston valve, and the high-pressure cylinder of the compound cylinder engine. 3500 w. Ir & Coal Trds Rev—July 8, 1910. No. 15685 A.

Molding a Spiral Turbine Casing (Formen eines Spiralgehäuses von rundens, gleichmässig zunehmendem Querschnitt mittels Modellgerippe). N. Ifkowitsch. Describes the tools and methods used. Ills. 2500 w. Giesserei-Zeit—June 15, 1910. No. 15784 D.

Molding Sand.

Coal Dust in Molding Sand (Der Kohlenstaub im Formsand und seine Bewertung). C. Henning. Discusses its effects and advantages. Discussion. 3200 w. Stahl u Eisen—June 1, 1910. No. 15763 D.

Pipe Founding.

Machine-Made Molds for Casting Pipes on End. R. Ardelt, in *Stahl u Eisen*. Illustrates and describes various devices tried, pointing out their defects, and illustrating the machine invented by the author which is believed to meet all requirements. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15568 A.

Planers.

Discussion of Planer Feeds. E. H. Fish. Shows that the split-ring friction is not as great a saver of power as is sometimes claimed, and explains the design of a positive rachet feed for severe service. 1500 w. Am Mach—Vol. 33. No. 30. No. 16009.

Press Work.

Making Aluminum Gas Tips. Illustrates and describes the machine and tools used in the work. 1000 w. Am Mach—Vol. 33. No. 26. No. 15337.

Manufacturing a Novel Jar Cap. Frank A. Stanley. An illustrated account of the press equipment and operating details. 1500 w. Am Mach—Vol. 33. No. 29. No. 15694.

Saws.

The Newton 26-In. Cold Saw Cutting-Off Machine. Illustrated description of a high speed machine with a new feed-changing mechanism. 700 w. Ir Age—July 14, 1910. No. 15576.

Sheet-Metal Work.

Automobile Sheet Metal Patterns. William Neubecker. Illustrated article on patterns for different parts of the work, with various methods of constructing seams and joints. 1200 w. Met Work—July 2, 1910. Serial. 1st part. No. 15289.

Shop Appliances.

Jigs and Fixtures for Candy Machines. Illustrates and describes jigs and fixtures for close drilling. 1200 w. Am Mach—Vol. 33. No. 29. No. 15693.

Shop Heating.

The Heating, Ventilating and Air-Conditioning of Factories. Percival Robert Moses. The first of two articles reviewing the present practice as to temperature, humidity and purity. Ills. 5000 w. Engineering Magazine—August, 1910. No. 16002 B.

Shop Heating by Direct Radiation. Charles L. Hubbard. On the proper methods of installing and operating a system of this kind. Ills. 4500 w. Mach, N Y—July, 1910. No. 15371 C.

The Heating and Ventilation of Industrial Buildings (Le Chauffage et la Ventilation des Bâtiments industriels). A complete treatise on this subject. Ills. 80000 w. Tech Mod—June, 1910. (Sup.) No. 15726 F + F.

Shop Lighting.

Industrial Lighting with Incandescent Lamps. J. D. Hoit, P. F. Bauder, and H. S. Hall. Abstract of paper read before the Nat. Elec. Lgt. Assn. Briefly discusses the systems employed for satisfactory artificial illumination, reporting various plants visited where new methods have been introduced. 1500 w. Eng News—July 14, 1910. No. 15589.

Shop Practice.

Precision in Instrument Making. Illustrates and describes methods of extreme accuracy used in the manufacture of standard scientific instruments. 3000 w. Am Mach—Vol. 33. No. 27. No. 15440.

Methods in Making Transformer Coils. Machines used and methods of manufacture and testing are illustrated and described. 600 w. Am Mach—Vol. 33. No. 27. No. 15438.

Automobile Factory Practice. Ethan Viall. Illustrated description of methods used at the Olds Motor Works, Lansing, Mich. 1200 w. Mach, N Y—July, 1910. No. 15375 C.

Making the Atlas Motor Car. Snowden B. Redfield. Illustrates and describes work requiring careful boring, keying, and alining. 2000 w. Am Mach—Vol. 33. No. 27. No. 15434.

Work on Complicated Brass Valve. H. P. Cathcart. Illustrates and describes the different operations in machining the various parts, and the devices used. 1500 w. Am Mach—Vol. 33. No. 27. No. 15436.

Shop Kinks. Illustrates and describes labor-saving devices used in the shops of the Chicago & North-Western. 2500 w. Ry Age Gaz—July 1, 1910. No. 15363.

Shops.

The Brewster Shops of the Wheeling & Lake Erie. Plan and illustrated description of the shops and their equipment. 2200 w. Ry Age Gaz—July 1, 1910. No. 15364.

The Works of Messrs. W. T. Glover and Co. Limited, Trafford Park, Manchester. Illustrated detailed description of works for the manufacture of electric cables and appliances for their installation. 2000 w. Col Guard—June 24, 1910. Serial. 1st part. No. 15536 A.

Shop Ventilation.

Ventilation and Dust Removal in Cotton Mills. Discusses methods of improving the hygienic conditions in card rooms and gassing rooms. Ills. 1500 w. Prac Engr—June 24, 1910. Serial. 1st part. No. 15526 A.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Welding.

German Electric Welding Machines. Bruno Loewenherz. Illustrates and describes a variety of machines, of the resistance type, for manufacturing metal articles. 2000 w. Am Mach—Vol. 33. No. 26. No. 15339.

Wire Drawing.

The Wire Rod Mills of Wm. Cooke & Co. Limited, at the Tinsley Steel, Iron, and Wire Rope Works, Tinsley, Near Sheffield. Illustrated detailed description of new works and their equipment. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15570 A.

MATERIALS OF CONSTRUCTION.

Alloys.

German Silver for Casting Purposes. A. Napier. From *Foundry Trade Jour.* Discusses copper-nickel-zinc mixtures and their use. 1500 w. Mech Engr—July 8, 1910. No. 15667 A.

Alloy Steels.

Various Effects of Titanium on Steel. E. F. Lake. Information concerning this new alloying material and its effects. 1800 w. Am Mach—Vol. 33. No. 30. No. 16013.

See also Locomotive Construction, under MATERIALS OF CONSTRUCTION.

Bearing Metals.

Bearing Metals. A. Hague. Considers points of importance in choosing an alloy for bearing purposes, and discusses rigid bronzes, plastic white metals, and plastic bronzes. Ills. 8000 w. Engng—June 24, 1910. No. 15530 A.

Bronzes.

Determination of the Coefficient of Equivalence in the Case of Special Bronzes (Détermination du Coefficient d' Equivalence dans le Cas des Bronzes spéciaux). L. Guillet and L. Révillon. Reports a research on the influence of foreign elements on copper-tin alloys. Ills. 1500 w. Rev de Métal—June, 1910. No. 15710 E + F.

Cast Iron.

Chemical Standards for Gray Iron. John Jermain Porter. Presented at meeting of Am. Found. Assn. Summary of a report giving analysis of a wide range of iron castings including recommendations for standard chemical properties. 5000 w. Foundry—July, 1910. No. 15312.

Some Recent Tests of Cast Iron. Alexander E. Outerbridge, Jr. Read before the Am. Soc. for Test. Mat. Deals with the sensitiveness of cast iron to cooling influences. 900 w. Ir Age—July 7, 1910. No. 15307.

Segregation in Cast Iron (Ueber Entmischung von Gusseisen). H. Adammer. Gives a number of examples from actual practice. Discussion. Ills. 7000 w. Stahl u Eisen—June 1, 1910. No. 15762 D.

Breaking-Stress Formulae (Knickformeln). Th. Scharff. A comparison of various formulae for cast iron and other materials. Ills. Serial. 1st part. 1200 w. Deutsche Bau—June 1, 1910. No. 15905 B.

Heat Insulation.

Study of Thermal Insulators for Cars. C. R. Harris. A study to determine the efficiency of several thermal insulators when applied to metallic surfaces. Ills. 1000 w. Am Mach—Vol. 33. No. 29. No. 15697.

Metallography.

See Hoisting Ropes, under MINING AND METALLURGY, MINING.

Refractory Materials.

See Blast-Furnace Lining, under IRON AND STEEL.

Steel.

Heat Treatment of Steel. J. F. Springer. Reports scientific researches into the characteristics and behavior of different kinds of steel, and the effects of heating, overheating, etc. 2500 w. Boiler Maker—July, 1910. No. 15583.

Tool Steel.

The Durabilitv of Tool Steel. Editorial on the conclusions of a recent paper by Edward G. Herbert, read before the Iron and Steel Institute. 1800 w. Ry Age Gaz—July 1, 1910. No. 15361.

MEASUREMENT.

Cyclometers.

Driving-wheel Distance Meters (Der dem Fahrrad angeborene Kilometerzähler). Otto Schuch. Describes the method of utilizing the driving wheel as a distance meter in any chain-transmission vehicle. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—June 16, 1910. No. 15940 D.

Dynamometers.

The Hopkins Gasolene-Engine Dynamometer and Speedometer. N. Monroe Hopkins. Illustrated detailed description of the apparatus and of experimental work. 1400 w. Jour Fr Inst—July, 1910. No. 15847 D.

Application of the Cradle-Dynamometer to the Testing of Electrical Machinery. J. Davies and F. Shaw. Read before the Manchester Students Sec. of the Inst. of Elec. Engrs. Describes the dynamometer used at the Manchester School of Technology, the cradle being supported on ball bearings instead of the customary knife edges. Gives experiments. Ills. 2200 w. Elect'n, Lond—July 8, 1910. No. 15662 A.

Hardness.

The Hardness Test as an Acceptance Test for Iron and Steel (Impiego delle Prove di Durezza nei Collandi dei Prodotti siderurgici). Gives the results and conclusions of an investigation by the Italian State Railways. Ills. 6000 w. Ing Ferro—June 16, 1910. No. 15759 D.

Laboratories.

Laboratories at University of Toronto. R. W. Angus. Illustrates and describes the mechanical equipment in steam engine, gas engine and hydraulic laboratories. 3000 w. Power—July 26, 1910. No. 15980.

Pyrometry.

Some Applications of Electric Pyrometry (Quelques Applications des Pyromètres électriques). M. Henry. Describes particularly the uses of recording pyrometers. Ills. 2000 w. L'Elecn—June 25, 1910. No. 15719 D.

See also Heating, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Rotating Speed.

An Accurate Electrical Method of Measuring Speeds of Rotation. E. B. Brown. A brief description of apparatus employed and method of experiment. 1000 w. Elect'n, Lond—June 24, 1910. No. 15518 A.

Testing Methods.

Inspection and Testing of Cast Iron and Steel. Stanley M. Udale. Suggestions for the testing of raw materials and semi-manufactured materials, entering the factory. Ills. 2000 w. Horseless Age—July 6, 1910. No. 15490.

Torsion Meters.

Some Types of Torsion Meter. Edward P. Buffet. Illustrates and describes various types. 3500 w. Power—July 19, 1910. No. 15651.

Vacuum Gauges.

Vacuum Gauges and Barometric-Vacuum Gauges for Condenser Plants, etc. Illustrates and describes types. 1200 w. Mech Engr—July 15, 1910. No. 15896 A.

Water.

Gauging by Titration (Jaugeages par Titrations). A. Boucher. Application of Chloride Titration to the Measurement of Turbine Discharges (Application de la Titration des Chlorures au Jaugeage de Débits). R. Mellet. Describes fully this method of measuring water. 4000 w. Bul Tech d l Suisse Romande—June 10, 1910. No. 15730 D.

Wheel Testing.

Recent Developments in Wheel Testing at Purdue University. Charles H. Benjamin. Describes a testing-pit recently established, and reviews the progress made in experimentation with rotating members. Ills. Also general discussion. 4000 w. Jour Assn of Engng Socs—June, 1910. No. 15986 C.

POWER AND TRANSMISSION.

Belt Driving.

An Unexpected Power Factor. Charles C. Klein. Explains conditions and the cause of an increase in the friction load in a textile mill. 1400 w. Power—July 12, 1910. No. 15444.

Belts.

Leather for Belting Purposes. Frederic Dannerth. Enumerates the processes which transforms the raw hide into the finished belt and gives hints on the use of belt-dressing and the care of belts. 1800 w. Power—July 19, 1910. No. 15652.

Electric Driving.

See Meters, under ELECTRICAL ENGINEERING, MEASUREMENT.

Lubricants.

Selection of Lubricating Oils. Charles B. Arnold. Flash point, specific gravity and viscosity must be carefully considered. 1000 w. Power—July 26, 1910. No. 15981.

Peak Loads.

The Peak-of-the-Load Problem. Editorial discussion of this problem in many engineering industries, with helpful suggestions. 2200 w. Eng News—July 7, 1910. No. 15409.

Turbo-Compressors.

See Turbines, under STEAM ENGINEERING.

STEAM ENGINEERING.

Air Pumps.

Westinghouse-Leblanc Centrifugal Air Pumps with Condensers (Westinghouse-Leblanc Schleuderrad-Luftpumpen mit Kondensatoren). Description, report of tests and performance, and illustrations of installations. 4200 w. Glasers Ann—June 1, 1910. No. 15923 D.

Boiler Economy.

Boiler Fuel Leaks. Edward B. Myers. Read before the Iowa Dist. Gas Assn. Considers the losses incidental to the production of steam, due to the poor design or improper operation of the boiler, and the losses in the distribution or use of the steam. 3000 w. Am Gas Lgt Jour—July 25, 1910. No. 15871.

Boiler Explosions.

Boiler Explosions and Their Causes. G. W. Buckwell. Read before the Barrow & District Assn. of Engrs. Briefly considers the scientific causes, given in the early seventies, to account for boiler explosions, and the present explanations and how to prevent explosions. Gives brief outline of explosions and their causes. 1500 w. Boiler Maker—July, 1910. No. 15581.

Boiler Furnaces.

A Japanese Design of Boiler Furnace. Y. Sekiguchi. Illustrated description of a novel design. 1200 w. Mech Engr—June 24, 1910. No. 15530 A.

Boiler Repairs.

Applying Patches to Boilers. H. S. Jeffery. Shows that the method of repairing depends on the nature and location of the defect. Illustrates and describes various repairs. 2500 w. Power—July 5, 1910. No. 15322.

Boilers.

The Grille Water-Tube Boiler. Illustrated detailed description of a novel type. The utmost stress has been laid on the idea of accessibility. 1400 w. Engr, Lond—July 1, 1910. No. 15565 A.

Boiler Selection.

Selecting a Boiler. F. C. Bitgood. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Deals with facts regarding different classes of boilers, pointing out the best way to make a selection for a given service. 2000 w. Boiler Maker—July, 1910. No. 15584.

Boiler Tests.

Test of a Boiler Plant Equipped with Superheaters (Untersuchung einer nachträglich mit Ueberhitzern ausgerüsteten Dampfkesselanlage). Gives results of tests before and after the installation of the superheaters. 2700 w. Glückauf—June 18, 1910. No. 15794 D.

Boiler Tubes.

Permissible Variation of Fire Tubes from the Circular (Zur Frage der zulässigen Abweichungen der Flammrohre von der Kreisform). C. Bach. Discusses the German regulations. Ills. 2300 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15952 D.

Condensers.

Clean Water for Condensing Purposes. Warren O. Rogers. Illustrated description of a concrete raceway constructed with automatic gateway to supply clean water from a pond. 1000 w. Power—July 12, 1910. No. 15442.

The Surface Condenser in Mine Power Plants. W. A. MacLeod. Gives results of condensation with intermittent prime movers. 2200 w. Eng & Min Jour—July 16, 1910. No. 15623.

Development of the Leblanc Condenser in America. R. N. Ehrhart. Gives a detailed description of the Leblanc air pump in connection with the condenser. Ills. 1200 w. Elec Jour—July, 1910. No. 15851.

See also Vacuum Gauges, under MEASUREMENT.

Engine Cranks.

Crank Troubles. Hints on dealing with various crank troubles. 1200 w. Elec Rev, Lond—June 21, 1910. No. 15514 A.

Engine Foundations.

Concrete for Machinery Foundations. G. Wise. Considers the material used, mixing, forms, pouring and finishing. 1800 w. Power—July 26, 1910. No. 15983.

Engine Lubrication.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engines.

The Revival of the Reciprocating Steam Engine. R. J. S. Pigott. This second of two articles discusses practical applications and the calculating of an engine-turbine combination for a given case. Ills. 3500 w. Engineering Magazine—August, 1910. No. 16003 B.

The Stumpf Uni-Directional-Flow Engine. Prof. J. Stumpf. Abridged translation of a communication on a type of engine first known through a British patent granted to Leonard Jennett Todd, under the title of "Mid-Cylinder Exhaust Engines." Claims remarkable advantages for this type of exhaust rendering it particularly valuable for engines using superheated steam. Ills. 4500 w. Engng —June 10, 1910. No. 15501 A.

Compound Engine with Müllerdrop-Valve Gear of the Zwickauer Maschinenfabrik (Machine à Vapeur compound à Distribution par Soupapes, système Müller, de la Zwickauer Maschinenfabrik). F. Hofer. Illustrated description. 2000 w. Génie Civil—June 25, 1910. No. 15740 D.

Prime Movers at the Brussels Exhibition (Der Kraftmaschinenbau auf der Weltausstellung in Brüssel 1910). H. Dubbel. A preliminary report on the gas-engine, steam-engine and steam-turbine exhibits. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15949 D.

Engine Testing.

Engine Erecting and Testing Pits. H. Pearman. Considers the requirements in pits suitable for the erection and testing of reciprocating engines. Ills. 800 w. Mech. Wld—July 8, 1910. Serial. 1st part. No. 15669 A.

Flue-Gas Analysis.

How to Make a Flue-Gas Analysis. Julian C. Smallwood. Description of Orsat flue-gas analyzing apparatus and the method of operation. Directions for preparing chemical solutions used in the apparatus, and suggestions on errors which influence the accuracy. 3000 w. Power—July 9, 1910. No. 15651.

Fuels.

The Influences of the Volatile Constituents in Coal Combustion. Editorial review of tests conducted by Prof. E. J. Constam and Dr. P. Schläpfer and described in the *Zeit. des Ver. Deut. Ing.* 2000 w. Engng—July 15, 1910. No. 15974 A.

Mechanical Stokers.

Notes on Western Anthracite Coal. A. G. Christie. Confirms the belief that some types of mechanical stokers are better adapted than others to burn certain kinds of coal, and refers particularly to the Roney stoker. 3000 w. Power—July 19, 1910. No. 15653.

Front Feed Automatic Stokers. J. F. Springer. Illustrates and describes types, explaining their operation. 3000 w. Power—July 12, 1910. No. 15443.

Rotary Engines.

Modern Rotary Steam Engines. Warren O. Rogers. An illustrated study of the construction of several makes of this type of engine. 3500 w. Power—July 5, 1910. No. 15326.

Smoke Prevention.

Smoke Abatement: Two Typical Reports. John B. C. Kershaw. Gives a brief résumé of these two reports, with editorial comment. 2500 w. Elec Rev, Lond—July 15, 1910. No. 15890 A.

Chicago's Smoke Problem. Paul P. Bird. A general paper on this subject, introducing a discussion. 26800 w. Jour W Soc of Engrs—June, 1910. No. 15854 D.

Smoke Recorders.

The Wattles Stoking Register. Illustrates and describes an apparatus which gives photographically a 24-hour record of smoke density in chimneys. 1000 w. Ir Age—July 21, 1910. No. 15801.

Stacks.

Chimneys and Draft. John S. Leese. Considers the temperature at which maximum draft is secured, and gives formula for estimating the drafts which a given chimney is capable of developing. 1200 w. Power—July 5, 1910. No. 15327.

Steam Pipes.

Resistance to Pressure of Oval Pipes (Résistance des Tuyaux ovales soumis à des Pressions). M. Westphal. Translated from the *Zeitschr. d. Ver. Deutscher Ing.* for July 24, 1909. Ills. 2500 w. Rev de Mécan—June, 1910. No. 15717 E + F.

Steam Properties.

Alignment Chart for Determining Specific Volumes of Steam. William J. Goudie. Gives a chart designed to reduce the labor of calculation when volumes cannot be obtained directly from the tables, explaining its use. 1000 w. Engng—July 1, 1910. No. 15542 A.

Superheating.

Superheaters (Quelques Surchauffeurs). A review of superheating devices recently patented and described. Ills. 6000 w. Rev de Mécan—June, 1910. No. 15718 E + F.

See also Boiler Tests, under STEAM ENGINEERING.

Turbine Design.

High-Speed Steam-Turbine Rotor Design and Construction. John McKenzie Newton. Read before the Jr. Inst. of Engrs. Discusses the mechanical design and construction of the rotors of such turbines, especially the mechanical strength and stiffness in relation to the materials. Ills. 8000 w. Engng—July 8, 1910. Serial. 1st part. No. 15678 A.

Diagrams for the Investigation of Turbine Rotors (Ein ereweitertes Diagramm mit verschiedenen Wirkungsgraden für die Teilturbinen und dessen Anwendung zur Untersuchung von Laufrädern). C. Reindl. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—June 30, 1910. No. 15915 D.

Turbine Governing.

The Indirect Intertia Governor (Der indirekt wirkende Beharrungsregler). D. Thoma. Discusses its application to hydraulic turbines. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—June 20, 1910. No. 15913 D.

Turbine Plants.

Brush-Parsons Exhaust Turbines. Illustrated detailed description of an exhaust-turbine plant installed in Belfast. 3500 w. Engng—July 1,1910. No. 15541 A.

The Exhaust-Steam Turbogenerator Plant at the "Fröhliche Morgensonne" Mine (Die Abdampf-Turbogeneratoranlage auf Zeche "Fröhliche Morgensonne"). Illustrated description. 2000 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1910. No. 15911 D.

Turbines.

Small Steam Turbines. John Gurney Callan. Considers the general type best suited to small units, and the mechanical arrangement most advantageous. Ills. 4000 w. Jour Assn of Engng Socs—June, 1910. No. 15987 C.

The Utilization of Exhaust Steam. Herman Niemetz. On the advantages of exhaust-steam turbines. Ills. 1500 w. Elec Wld—July 7, 1910. No. 15486.

Atmospheric or Low Pressure Turbines. J. A. MacMurchy. An illustrated article explaining the advantages of these turbines. 1700 w. Can Elec News—July, 1910. No. 15447.

I. Exhaust Steam Turbines and Condensing Plant at McDonald Road Station. Frank A. Newington. II. Extensions to Existing Electricity Supply Stations by Means of Mixed Pressure Turbines. Ashton Bremner. Two papers before the Munic. Elec. Assn., discussed together. 6000 w. Elec Engr, Lond—June 24, 1910. No. 15511 A.

The New Tosi Steam Turbines (Die neueren Dampfturbinen der Firma Franco Tosi, Legnano). W. Gensecke. Illustrated detailed description. Serial. 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—June 30, 1910. No. 15914 D.

Multi-Stage Turbo-Machines and Recent Applications (Les Turbo-Machines multicellulaires et leurs récentes Applications). A. Rateau. Discusses steam turbines, centrifugal pumps, fans and compressors. Ills. 13000 w. Mem Soc Ing Civ de France—April, 1910. No. 15702 G.

A Description of Some Turbo-Machines and a Comparison with the Corresponding Piston Machines (Description de quelques Turbo-Machines et Comparaisons de Celles-ci avec les Machines à Piston correspondantes). A. Barbezat. Deals with centrifugal pumps of the Société de la Meuse, Rateau turbo-compressors, and Barbezat steam turbines. Ills. 15000 w. Mem Soc Ing Civ de France—April, 1910. No. 15703 G.

Some Notes on Turbo-Machines (Quelques Remarques sur les Turbo-Machines). J. Rey. A brief review of the evolution of steam turbines, centrifugal pumps and compressors. Ills. 8000 w. Mem Soc Ing Civ de France—April, 1910. No. 15704 G.

See also Engines, under STEAM ENGINEERING.

Watt Museum.

The Watt Relics at South Kensington F. A. Halsey. Illustrates and describes the more important of the Watt exhibits. 3000 w. Power—July 26, 1910. No. 15984.

The Watt Relics at South Kensington. F. A. Halsey. Illustrates and describes models, showing the importance of Watt's work. 2800 w. Am Mach—Vol. 33. No. 28. No. 15586.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electric Aerial Tramways in Foundries (Elektrische Hängebahnen in Giessereien). Illustrates and describes a number of installations on the Bleichert system. Serial. 1st part. 2500 w. Giesserei-Zeit —June 15, 1910. No. 15783 D.

Cranes.

Travelling and Slewing Tower Transporter. Illustrations and description of a transporter for Victoria Docks, operated electrically. 800 w. Engr, Lond—July 1, 1910. No. 15566 A.

150-Ton Hammer-Head Crane. Plate, illustrations, and description of an electrically operated hammer-head crane for the Mitou Bishi Dockyard, Nagasaki, Japan. 2000 w. Engng—June 24, 1910. No. 15538 A.

See also Floating Cranes, under MARINE AND NAVAL ENGINEERING.

Elevators.

The Electric Elevator. William Baxter, Jr. Illustrated description of the elektron system with mechanical control. 1500 w. Power—July 5, 1910. No. 15325.

Electric Lifts on the Olympic and Titanic. Brief description of elevators for passengers, stores, and pantry service. 700 w. Engr, Lond—June 24, 1910. No. 15551 A.

A Novel Mountain Elevator. L. Ramakers. Illustrated description of an elevator recently put in service in Switzerland. 1000 w. Sci Am—July 23, 1910. No. 15800.

The Safety of Industrial Elevators (Gli Elevatori industriali Considerati nei Riguardi della Sicurezza del loro Esercizio). L. Pontiggia. Discusses the regulations governing the installation and operation of passenger and freight elevators in various countries. Serial. 1st part. 2500 w. Industria—June 19, 1910. No. 15750 D.

Freight Handling.

Mechanical Transference of Water-Borne Freight. H. M'L. Harding. Describes the methods now employed at steamship terminals, showing the requirements of the service, discussing the value of mechanical conveyors for the handling of freight, and especially the economy of the electric hoist. 4500 w. Ry Age Gaz—July 8, 1910. No. 15468.

Lifting Magnets.

Electric Lifting Magnets in the Steel Plant. Illustrated article on the important uses of this conveying device. 1500 w. Elec Wld—July 7, 1910. No. 15485.

Ore Handling.

A 15-Ton Hulett Ore Unloader. Walter G. Stephan. Illustrated description of a new machine with 50 per cent. increase in bucket load and with receiving hopper, larry car, and mechanism for weighing the ore. 1800 w. Ir Age—July 21, 1910. No. 15800.

MISCELLANY.

Aeronautics.

Alphonse Pénaud, the Father of Modern Aviation (Alphonse Pénaud, der Vater der modernen Aviatik). Josef Popper. A review of the development of the fundamental principles of aeronautics. Serial. 1st part. 2000 w. Motorwagen—June 20, 1910. No. 15920 D.

Aerial Navigation (Sulla Navigazione aerea). Angelo Battelli. A discussion of its present development and possible future. 6000 w. Monit Tech—June 20, 1910. No. 15751 D.

Aeroplanes and Dirigibles in Naval Warfare (Velivoli e Dirigibili nella Guerra navale). Claudio Piumatti. A discussion of their offensive and defensive possibilities. 2000 w. Riv Marit—June, 1910. No. 15746 E + F.

By Air Across the Atlantic Ocean. Dr. Eugen Alt. Brief account of a projected aerial voyage from Europe to America. 1800 w. Sci Am Sup—July 2, 1910. No. 15405.

The Principle of the Helicopter. Herbert Chatley. Reports results of investigation of theoretical points in connection with the design and construction of this type of machine. 1000 w. Engr, Lond—July 1, 1910. No. 15558 A.

Wooden Construction for the Framework of Airships (Holzträger für Gerippe von Luftschiffen). Herr Lukomski. Discusses the design of wood frameworks. Ills. 1000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15953 D.

Analytical Calculation of Pressure and Pressure Distribution on Planes (Analytische Berechnung der Druckkraft und Druckverteilung an luftbestromten Flächen). Erich Schneckenberg. Mathematical discussion of this element of aeroplane design. Ills. 2000 w. Elektrotech Rundschau—June 2, 1910. No. 15939 D.

The Theory, Calculation, and Construction of Aerial Propellers (Sur la Théorie, le Calcul et la Construction des Hélices aériennes). Ernest Comhaire. A brief review of aerial propeller design and construction. 2000 w. All Indus—June, 1910. No. 15728 D.

Testing Aerial Propellers. Illustrated description of a special apparatus at the works of the Vickers Co. for making practical tests of such propellers, with an outline of testing methods. 700 w. Engng—July 8, 1910. No. 15670 A.

Tests on Air Propellers (Versuche mit Hubschrauben). G. Klingenberg. Describes methods and gives results and conclusions. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15951 D.

Aeroplane Constructional Details. Warren H. Miller. Discusses materials used and describes some constructional details. Ills. 3500 w. Am Mach—Vol. 33. No. 29. No. 15696.

The Antoinette Aeroplane (L'Aéroplane Antoinette). Describes in detail the construction of the aeroplane and motor. Ills. 2500 w. Tech Mod—June, 1910. No. 15725 D.

The Manufacture of French Aeroplanes. Warren H. Miller. Reviews the mechanical and trade developments in this new industry in France. Ills. 2000 w. Engineering Magazine—August, 1910. No. 15998 B.

The Wreck of the "Deutschland." Carl Dienstbach. An account of the loss of the third airship of Count Zeppelin. 1200 w. Sci Am—July 9, 1910. No. 15414.

Contemporary Dirigible Balloons (Les Aérostats dirigeables contemporains). Paul Renard. A discussion of their design and a description of various types. Ills. Serial. 1st part. 4500 w. Tech Mod—June, 1910. No. 15724 D.

See also Aeronautic Motors, under COMBUSTION MOTORS.

Agricultural Implements.

The Royal Agricultural Society's Show. Illustrates and describes interesting exhibits in the implement section. 3300 w. Engr, Lond—June 24, 1910. Serial. 1st part. No. 15548 A.

Safety Devices.

Prevention of Industrial Accidents. Frederick R. Hutton. Analysis of industrial accidents showing the importance of safety devices. Editorial note. 1800 w. Am Mach—Vol. 33. No. 30. No. 16012.

MINING AND METALLURGY.

COAL AND COKE.

Briquetting.

Binders for Coal Briquets. C. L. Hubbard. Summary of results and recommendations from a bulletin issued by the U. S. Geol. Survey relating to tests made at the St. Louis plant. 2500 w. Elec Rev, N Y—July 16, 1910. No. 15639.

Coal Breakers.

The Beaver Brook Breakers. Truman M. Dodson, Jr. Illustrates and describes the equipment and construction for preparing anthracite. 3500 w. Mines & Min—July, 1910. No. 15342 C.

Coal Cutting.

Advantages and disadvantages of the Electric and Compressed Air Drive for Coal-Cutting Machines. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15573 A.

Coke-Oven Gas.

See Open-Hearth Furnaces, under Iron and Steel.

Coke-Oven Lining.

See Blast-Furnace Lining, under Iron and Steel.

Coke Ovens.

The Coppée Regenerative By-Product Coke Oven (Etude sur le Four à Coke à Régénération de Chaleur et à Récupération des Sous-Produits, Système Evence Coppée). Pierre Gilard. Describes the construction and operation of the oven and by-product recovery plant. Ills. 3600 w. Bul Sci d l'Assn d Elèves—April, 1910. No. 15701 D.

Coke Waterer.

An Automatic Coke Waterer. William L. Affelder. Illustrates and describes apparatus for overcoming some difficulties of operating rectangular coke ovens. 2200 w. Mines & Min—July, 1910. No. 15345 C.

Coking By-Products.

A New Method for the Recovery of Ammonia from the Products of Coal Distillation (Ein neues Verfahren zur Gewinnung des Ammoniaks aus Kohlendestillationsgasen). J. Reintgen. Describes the Burkheiser process. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—June 11, 1910. No. 15948 D.

Electric Power.

Electricity in Mining Operations. J. Glynn Williams. Discussion and suggestions concerning the application of electricity to mining plants. 4500 w. Ir & Coal Trds Rev—July 1, 1910. No. 15572 A.

Electricity in West Virginia Mines. R. Neil Williams. On the economic advantages of electric operation, with a review of the development at the bituminous mines of West Virginia. Ills. 3500 w. Eng & Min Jour—July 2, 1910. No. 15355.

Electricity Rules at the Eastwood Collieries. Instructions given to those in charge of electric plant on the surface and underground, and also of coal-cutting machines. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15571 A.

England.

Coal Mines Inspection—1909. Digest of the reports of H. M. Inspector of Mines. 63000 w. Col Guard (Sup)—July 15, 1910. No. 15899 A.

Mexico.

Coal Mining Industry of the Mexican Republic. Edwin Ludlow. A review of the three developed coal basins in the state of Coahuila giving analyses and report of commercial conditions. 2000 w. Min Wld—July 9, 1910. No. 15467.

Mine Equipment.

Coal-Mine Equipment. W. S. Meyers. Abstract of paper read at Bluefield meeting of the W. Va. Coal Min. Inst. Deals with the kind of power; the generation and transmission of electricity, etc. 3500 w. Mines & Min—July, 1910. No. 15347 C.

Mine Power.

I. Some Considerations Affecting the Installation of Power at Collieries. F. Onslow. II. Power Production at Collieries, with Special Reference to Gas Power and Electrical Centralization. R. Crawford and H. Moores. Abstracts of two papers before the Min. Inst. of Scotland. 2500 w. Elect'n, London—June 24, 1910. No. 15519 A.

Mining.

Vital Facts Pertaining to Coal Mining. Floyd W. Parsons. A condensed review of recent practice. 6000 w. Eng & Min Jour—July 16, 1910. No. 15624.

Systematic Exploitation in the Pittsburg Coal-Seam. F. Z. Schellenberg. Shows methods of rib-drawing and of working in the Pittsburg region. 2000 w. Bul Am Inst of Min Engrs—July, 1910. No. 15858 F.

Hydraulic Breaking in Bituminous-Coal Mining (Stosstränken und hydraulische Kohlensprengung in Steinkohlenflözen). Herr Trippe. Read at the Düsseldorf Congress. Describes a method of coal mining which prevents the formation of dust. Ills. 4000 w. Glückauf—June 25, 1910. No. 15707 D.

A Criticism of Stoping (Kritik des Schüttelrutschenbetriebes). F. Jüngst. A comparison of overhand stoping with long-wall and other mining methods. 8000 w. Glückauf—June 18, 1910. No. 15791 D.

Nova Scotia.

See Rhode Island, under Coal and Coke.

Peat.

Geologic Bearing of the Peat Beds of Anticosti Island. W. H. Twenhofel. Gives facts bearing on the method of deposition of the coal and on the climate of past coal-forming times. 3000 w. Am Jour of Sci—July, 1910. No. 15286 D.

Rescue Appliances.

Comparative Tests with Breathing Appliances (Vergelichende Versuche mit Atmungsapparaten). Herr Grahn. Discusses pricipally the Tissot apparatus. Ills. 2000 w. Glückauf—June 11, 1910. No. 15790 D.

Rescue Stations.

Mine Rescue Stations in Illinois. R. Y. Williams. Describes the design and equipment and the character of the training given. 3000 w. Eng & Min Jour—July 23, 1910. No. 15877.

Rhode Island.

The Northern Appalachian, Rhode Island and Nova Scotia Coal Fields. Information from the report of the fuel committee of the Boston Chamber of Commerce. 2500 w. Ry Age Gaz—July 8, 1910. No. 15473.

Russia.

The Russian Coal Trade. Information concerning the competition with British coal in the Baltic, and new deposits in the Russian far east. 2000 w. Ir & Coal Trds Rev—July 15, 1910. No. 15997 A.

Washing.

Mechanical Preparation of Coal. H. H. Stoek. Read before the Int. Ry. Fuel Assn. Discusses the means of improving the fuel and increasing its value. 4500 w. Ry & Engng Rev—July 2, 1910. No. 15291.

COPPER.

Arizona.

Copper Mining in Metcalf District, Arizona. Peter B. Scotland. Illustrated description of methods used in handling low-grade ore. 5000 w. Eng & Min Jour—July 16, 1910. No. 15622.

Mining at Miami, Arizona. R. L. Herrick. Illustrated description of mine developments. 7500 w. Mines & Min—July, 1910. No. 15349 C.

Converters.

Converting Copper Mattes. H. Schroder. Illustrates and describes details of interesting work. 1500 w. Aust Min Stand—June 1, 1910. Serial. 1st part. No. 15504 B.

Flue Dust.

Flue Dust and Fume in Smeltery Gases. Lewis T. Wright. Explains how flue dust deposition was controlled by velocity, fume by temperature. 1700 w. Eng & Min Jour—July 16, 1910. No. 15620.

Germany.

Lead and Copper Deposits in Lower Silesia (Die Blei- und Kupfererzlagerstätten Neiderschlesiens und der auf ihnen betriebene Bergbau). A. Fleck. Describes the ore deposits and the mining operations. Ills. Serial. 1st part. 2500 w. Gluckauf—June 25, 1910. No. 15799 D.

Mexico.

Cananea Mining District of Sonora, Mexico. S. F. Emmons. Gives the principal scientific results of a survey made in 1907, describing especially the property of the Greene Cananea Copper Co. Map. 16000 w. Ec-Geol—June, 1910. No. 15842 D.

Cananea Consolidated Copper Co. in 1909. L. D. Ricketts. Abstract from the 1909 report of the Greene Consolidated Copper Co. 3500 w. Eng & Min Jour—July 9, 1910. No. 15462.

Nevada.

The Yerington Copper District. Jay A. Carpenter. Illustrated article reviewing the history of this district and describing the mines. 4000 w. Min & Sci Pr—July 2, 1910. No. 15431.

Slags.

Heats of Formation of Some Ferro-Calcic Silicates. H. O. Hofman and C. Y. Wen. Reports an investigation made to supply heat values as far as possible. Ills. 3500 w. Bul Am Inst of Min Engrs—July, 1910. No. 15861 F.

Smelter Fumes.

See Flue Dust, under COPPER.

Smelters.

Smelting Works of Tezeutlan Copper Company. A. van Zwaluwenburg. Illustrated description of a plant utilizing gravity in handling all material. 2800 w. Eng & Min Jour—July 23, 1910. No. 15875.

Smelting.

Cananea Furnace Practice. Courtenay De Kalb. Detailed discussion of the practice at the great smelter of the Cananea Consolidated Copper Co. Ills. 3000 w. Min & Sci Pr—July 2, 1910. No. 15432.

See also Roasting, under ORE DRESSING AND CONCENTRATION.

Spain.

The Pyritic Deposits of Huelva, Spain. A. Moncrieff Finlayson. Gives results of investigations into the pyritic masses of the important copper district of southern Spain and Portugal. 4000 w. Ec-Geol—June, 1910. Serial. 1st part. No. 15843 D.

GOLD AND SILVER.

Australia.

Catherine Reef United Mine, Bendigo (V.). Describes a massive quartz deposit; the greater part being low-grade ore. 2500 w. Aust Min Stand—June 1, 1910. No. 15505 B.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

Cyaniding.

Continuous Pachuca Tank Agitation at the Esperanza Mill. M. H. Kuryla. Read before the Inst. Mexicano de Minas y Metalurgia. Describes the continuous system of agitation in treating the granular slime resulting from regrinding of the battery sands. 1000 w. Met & Chem Engng—July, 1910. No. 15430 C.

Silver Cyaniding at the San Rafael Mill, Pachuca. E. Girault. Describes the treatment and gives the per cent. of extraction and cost. Ills. 2000 w. Eng & Min Jour—July 9, 1910. No. 15461.

See also Crushing, under Ore Dressing and Concentration.

Dredging.

Less Known Gold Dredges in California. W. M. Knox. Brief descriptions of dredges working with good results in isolated districts. Ills. 1000 w. Min & Sci Pr—July 2, 1910. No. 15433.

Gold Dredging and Rock Crushing in California. George Bowers. Describes dredges and methods used successfully in the Folsom Division of the Natomas Consolidated. Ills. 2500 w. Eng Rec—July 16, 1910. No. 15628.

Georgia.

Gold Deposits of Georgia. E. K. Soper. Information concerning the deposits and their development. 2200 w. Min & Sci Pr—June 25, 1910. No. 15294.

Idaho.

Boise Basin, Idaho. W. A. Scott. Describes the locality and gives an account of placer mining in the past and present. 2000 w. Min & Sci Pr—July 16, 1910. No. 15825.

Nevada.

The Tonopah Extension Mine and Mill, Nevada. A. H. Martin. Illustrated description of the property. 1500 w. Min Wld—July 2, 1910. No. 15341.

Rawhide, Its Past, Present, and the Future. P. R. Whytock. Reviews the history of this mining district, describing the gold and silver ore deposits. Map. 2000 w. Min Wld—July 16, 1910. No. 15641.

Geology and Ore-Deposits of the Goldfield District, Nevada. F. L. Ransome. This present number gives map and description of the general geology of this district. 2500 w. Ec-Geol—June, 1910. Serial. 1st part. No. 15841 D.

Faulting in the Bullfrog District, Nevada. W. H. Emmons and G. H. Garrey. Abstract from Bull. 407, U. S. Geol. Surv. A descriptive study of this region. Ills. 2000 w. Min & Sci Pr—June 25, 1910. Serial. 1st part. No. 15296.

Rand.

Metallurgy on the Rand. Horace G. Nichols. Illustrations and report of conditions as observed on a recent trip to South Africa. 1000 w. Mining Mag—July, 1910. No. 15990 B.

South Dakota.

The Black Hills of South Dakota. Wililam H. Storms. An account of the discovery and matters related is given in the present number. Ills. Min & Sci Pr—July 23, 1910. Serial. 1st part. No. 16035.

Utah.

The Daly Judge Mine and Mill, Park City, Utah. Leroy A. Palmer. Illustrated detailed description. 3500 w. Min Wld—July 2, 1910. No. 15340.

IRON AND STEEL.

Bessemer Process.

The Present Status of the Basic Bessemer Process in Germany. Review and synopsis of a paper by W. Esser, read at the Int. Cong. at Dusseldorf, Germany. 3000 w. Ir Age—July 14, 1910. No.15575.

Introduction of the Thomas Basic Steel Process in the United States. George W. Maynard. Detailed review of the history of the process. 4000 w. Bul Am Inst of Min Engrs—July, 1910. No. 15862 F.

Blast-Furnace Charging.

The Mechanical Charging of Blast Furnaces. Edgar J. W. Richards and Thomas Lewis. Abstract of a paper read before the Cleveland Inst. of Engrs., England. Discuesses the requirements and reviews the chargers in use, describing a new design believed to be an improvement. Ills. 5000 w. Can Min Jour—July 15, 1910. No. 15635.

Blast-Furnace Gas.

A Quantitative Investigation of the Source of Hydrogen in Blast Furnace Gas. R. J. Wysor and W. D. Brown. Gives results of investigations, with details of the test. 2500 w. Met & Chem Engng—July, 1910. No. 15423 C.

The Cost of Electric Power from Furnace Gases (Die Erzeugungskosten der elektrischen Kraft unter Ausnutzung des Hochofengases). Rudolf Pokorny. Discusses the cost of power in both gas and steam plants. Ills. 4000 w. Stahl u Eisen--June 8, 1910. No. 15767 D.

See also Open-Hearth Furnaces, under Iron and Steel.

Blast-Furnace Lining.

Changes in the Composition of Refractory Materials (Ueber die Wandlung in der Zusammensetzung feuerfester Steine). Dr. Blasberg. Read at the Düsseldorf Congress. Gives a number of analyses showing the alteration of coke-oven and blast-furnace linings. 3000 w. Stahl u Eisen—June 22, 1910. No. 15770 D.

Blast-Furnace Operation.

Gruner's Ideal Working of a Blast Furnace. Joseph W. Richards. Read before the Int. Cong. of Min. & Met. Aims to show that this ideal is not true for some blast furnaces under usual conditions, and not true of many blast furnaces under certain unusual conditions. 1200 w. Met & Chem Engng—July, 1910. No. 15425 C.

The Fuel Economy of the Blast Furnace (Der Warmewert des Brennstoffes im Schachtofen und insbesonders im Eisenhochofen). Josef v. Ehrenwerth. A continuation of the author's papers begun in Sept., 1909, dealing specially with the iron blast furnace. Serial. 1st part. 2800

w. Oest Zeitschr f Berg u Huttenwesen—June 4, 1910. No. 15785 D.

Blast Furnaces.

The Reconstructed Earlston Furnace. Illustrates and describes interesting details of a reconstructed furnace at Everett, Pa. 1200 w. Ir Trd Rev—July 7, 1910. No. 15418.

New Plant and Blast Furnace of the Northwestern Iron Co., Mayville, Wis. Brief sketch of the location and history, with illustrated description of features of the mines and new furnace. 2500 w. Ir Trd Rev—July 28, 1910. No. 16032.

Blast-Furnace Slags.

A Metallographic Study of Iron and Steel Slags (Etude métallographique des Scories du Fer et de l'Acier). M. Matweieff. Illustrated with microphotographs. 2700 w. Rev de Métal—June, 1910. No. 15712 E + F.

The Value of Microscopic Study in the Examination of Blast-Furnace Slags (Ueber den Wert mikroskopischer Untersuchungen für die Beurteilung von Hochofenschlacke). H. Passow. Read at the Düsseldorf Congress. Shows what a microscopic investigation will reveal. Ills. 2500 w. Stahl u Eisen—June 15, 1910. No. 15770 D.

Blowers.

The Application of Turbo-Blowers to Blast Furnaces (Note sur l'Application des Souffleries rotatives aux Hauts Fourneaux). A. Gouvy. Reviews their advantages and shows their economy. Ills. 3000 w. Mem Soc Ing Civ de France—April, 1910. No. 15705 G.

The Driving of Steel-Works Blowers (Ueber die Wirtschaftlichkeit der verschiedenen Antriebsarten von Stahlwerks- Gebläsemaschinen). Herr Mauritz. Read at the Düsseldorf Congress. Discusses the economy of steam, gas, and electric operation. Ills. 4200 w. Stahl u Eisen—June 22, 1910. No. 15774 D.

Electrometallurgy.

The Development of Electric Smelting of Iron and Steel (Die Entwicklung der elektrischen Eisen- und Stahlerzeugung). Dr. Juliusburger. A review of electric-furnace types and operation. Ills. 3500 w. Elek Kraft u Bahnen—June 4, 1910. No. 15937 D.

Present Status of Electric Steel Production (Ueber den heutigen Stand der Elektrostahlverfahren). B. Neumann. Read at the Düsseldorf Congress. A review of the types of furnaces in use and the results obtained. Ills. 6000 w. Stahl u Eisen—June 22, 1910. No. 15778 D.

The Theoretical and Practical Importance of the Electric Shaft Furnace (Ueber die theoretische und praktische Bedeutung des elektrischen Hochofens). Carl Brisker. Read at the Düsseldorf Congress. Reviews results at Domnarfvet and discusses the possibilities of the shaft furnace. 10000 w. Stahl u Eisen—June 22, 1910. No. 15775 D.

Laboratories.

The Organization of Some German and Belgian Laboratories (Notes sur l'Organisation de quelques Laboratories allemands et belges). G. Arnou. Describes laboratory equipment and practice in some German and Belgian steel works. Ills. 6500 w. Rev de Métal—June, 1910. No. 15700 E + F.

Native Iron.

Native Iron (Ueber tellurisches Eisen). E. Priwoznik. Discusses the occurrence of pure iron in nature, reviewing the discoveries. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 11, 1910. No. 15786 D.

Open-Hearth Furnaces.

Recent Improvements in the Construction of the Open-Hearth Furnace. O. Friedrich. Read before the International Cong. at Düsseldorf. Explains some of the problems, and illustrates and describes improvements made. 2500 w. Ir & Coal Trds Rev—July 8, 1910. Serial. 1st part. No. 15686 A.

Recent Improvements in the Construction of Martin Furnaces (Neuere konstruktive Verbesserungen an Martinöfen). O. Friedrich. Read at the Düsseldorf Congress. Detailed description of new and important features. Ills. 5500 w. Stahl u Eisen—June 15, 1910. No. 15769 D.

The Application of Various Kinds of Gas to the Operation of Open-Hearth Furnaces and Their Influence on the Quality of the Product (Ueber die Verwendung der verschiedenen Gasarten zum Betrieb von Herdöfen und ihren Einfluss auf die Qualität der Erzeugnisse). Herr Terpitz. Read at the Düsseldorf Congress. Discusses the use of blast-furnace and coke-oven gases. 2500 w. Stahl u Eisen—June 15, 1910. No. 15773 D.

Open-Hearth Process.

German Open Hearth Processes. R. Genzmer. Synopsis of a paper read at the Dusseldorf Congress on "Pig Iron-Ore Processes in Germany." 2500 w. Ir Age—July 28, 1910. No. 16033.

Quebec.

I. Iron Ore Deposits of the Bristol Mine, Pontiac County, Que. E. Lindeman. II. Magnetic Concentration of Ores. George C. Mackenzie. The first article gives a report of a magnetometric survey, etc. Ills. Maps. 3300 w. Can Dept of Mines—Bul. No. 2. No. 16005 N.

Rolling Mills.

Early Days in the Rolling Mills. The address of John Fritz at the centennial celebration at Coatsville, Pa., telling of the opposition to his three-high mill. Ills. 3000 w. Ir Trd Rev—July 14, 1910. No. 15608.

A Modern Universal Rolling Mill

(Modernes Universal-Walzwerk). Details of a rolling mill embodying several new features. Ills. 1800 w. Stahl u Eisen—June 8, 1910. No. 15768 D.

A Decade's Progress in the Construction of Roll Trains (Konstruktive Neuerungen an Walzenstrassen im letzten Jahrzehnt. H. Ortmann. Read at the Düsseldorf Congress. A detailed illustrated review of recent improvements. 8500 w. Stahl u Eisen—June 15, 1910. No. 15772 D.

Segregation.

Titanium and Segregation. G. B. Waterhouse. Read before the Am. Soc. for Test. Mat. Discusses the influence of titanium on segregation in Bessemer rail steel. Ills. 1200 w. Ir Age—July 7, 1910. No. 15305.

Steel Works.

One Hundred and Thirty Years of Iron and Steel Making. Illustrated review of the development of the Lukins Iron & Steel Co., Coatesville, Pa. 3500 w. Ir Trd Rev—June 30, 1910. No. 15293.

Sweden.

Iron Mining in Sweden (Der Abbau der Eisenerze in Schweden). Herr Bentz. Describes mining methods in various localities. Ills. 5500 w. Glückauf—June 4, 1910. No. 15789 D.

LEAD AND ZINC.

Germany.

See same title, under Copper.

Kentucky.

The Fluorspar, Lead and Zinc Deposits of Western Kentucky. F. Julius Fohs. Describes these deposits of economic and scientific interest. 3000 w. Ec-Geol—June, 1910. No. 15845 D.

Lead Smelting.

Unhealthful Practices in the Metallurgy of Lead. Edgar L. Collins. Abstract of a "Special Report on Dangerous or Injurious Processes in the Smelting of Materials Containing Lead," made to the British Parliament. 1500 w. Eng & Min Jour—July 16, 1910. No. 15621.

Missouri.

Lead Mining in the Joplin District. Lucius L. Wittich. Describes early operations in the production of lead in connection with zinc mining. Ills. 3000 w. Mines & Min—July, 1910. No. 15348 C.

MINOR MINERALS.

Cement.

Aluminates; Their Properties and Possibilities in Cement Manufacture. Henry S. Spackman. Read before the Am. Soc. for Test. Mat. Aims to show the value of combinations of aluminates with a base as an addition to cements and mortars, and their power of increasing the strength and hydraulic properties. 2500 w. Eng Rec—July 9, 1910. No. 15452.

See also same title, under CIVIL ENGINEERING, Materials of Construction.

Fluorspar.

See Kentucky, under Lead and Zinc.

Natural Gas.

The Beginning of the Use of Natural Gas for Fuel. John L. Cowan. Refers to ancient uses, and gives an account of its early commercial supplies. 2200 w. Min & Sci Pr—July 9, 1910. No. 15601.

Natural Gas and Its Production. Harold A. Danne. Information concerning these deposits, their use, wasteful methods, theories relating to their generation, and related subjects. 2000 w. Met & Chem Engng—July, 1910. No. 15428 C.

Natural Gas Field Near Fayette, Ala. Dr. David T. Day. Describes the supply found and the development work, giving a log of well No. 1. 1200 w. Mfrs' Rec—July 7, 1910. No. 15393.

Future of Natural Gas in Oklahoma. Charles N. Gould. Read before the Nat. Gas Assn. of America. Discusses the location, quantity, and utilization of this product in Oklahoma. Maps. 5500 w. Pro Age—July 15, 1910. No. 15578.

The Conservation of Natural Gas. J. C. McDowell. Read before the Nat. Gas Assn. of America. Brief review of the history and utilization of this product in the regions discovered and developed, discussing the waste. 3000 w. Pro Age—July 15, 1910. No. 15577.

Nickel.

The Alexo Nickel Deposit. A. P. Coleman. Brief description of this interesting deposit in Northern Ontario. Ills. 700 w. Ec-Geol—June, 1910. No. 15844 D.

Nitrates.

History and Review of the Niter Industry of Chile. Mark R. Lamb. Information from a new book by Semper and Nichols, Santiago, Chile, giving an exhaustive review of the history of this industry. Ills. 5500 w. Eng & Min Jour—July 2, 1910. No. 15354.

Oil.

The Oilfields of Mexico. H. S. Denny. Map and report of this oil region and its development. 3000 w. Mining Mag—July, 1910. No. 15989 B.

The Economics of the Petroleum Industry (Der Wirtschaftsbetrieb des Erdöles). F. W. Möller. A review of the petroleum industry of the world. Ills. Serial. 1st part. 2000 w. Tech u Wirt—June, 1910. No. 15963 D.

Tin.

The Tin-Mining Industry of Cornwall. A review of this industry in England and the methods of mining under the sea. 2500 w. Sci Am Sup—July 30, 1910. No. 16031.

MINING.

Accidents.

Mining Accidents. Gives statistics showing a recent increase in mine accidents, and discusses the causes. 1200 w. Engr, Lond—July 1, 1910. No. 15556 A.

Boring.

A Remarkable Drill Core. An illustration of the practicability of drilling holes 29 inches in diameter and saving core. 1500 w. Mines & Min—July, 1910. No. 15346 C.

Electric Hoisting.

Progress in the Construction of Electric Hoists to 1910 (Fortschritte im Bau elektrischer Fördermaschinen bis 1910). Josef Blazet. Discusses the cost of electric hoisting plants, improvements in efficiency, etc. Ills. Serial. 1st part. 3600 w. Oest Zeitschr f Berg u Hüttenwesen—June 18, 1910. No. 15787 D.

Haulage.

Electric Rope Haulage. W. O. Vickery. Describes the system in use at Midway Mine, Colorado, which is a combination of electric hoists and tail rope haulage. 2800 w. Mines & Min—July, 1910. No. 15343 C.

Protection of Trolley Wires in Electric Mine Haulage (Schutzmassnahmen gegen Berühren der Fahrdrähte elektrischer Grubenbahnen). Herr Spackeler. Describes a number of devices to prevent contact with the wires. Ills. 3500 w. Glückauf—June 25, 1910. No. 15798 D.

Hoisting Ropes.

Mechanical Investigation of the Influence of Galvanizing on Hoisting Ropes (Mechanische Untersuchungen über den Einfluss der Verzinkung auf Förderseildrähte). Herr Speer. Describes the tests and gives the results in detail. Serial. 1st part. 5600 w. Glückauf—June 4, 1910. No. 15788 D.

Metallographic Investigation of the Influence of Galvanizing on Winding Ropes (Metallographische Untersuchungen über den Einfluss der Verzinkung auf Forderseildrähte). H. Winter. Read at the Düsseldorf Congress. An exhaustive discussion of the effect of protective treatment. Ills. 8500 w. Glückauf—June 18, 1910. No. 15793 D.

Hydraulic Mining.

The Long-Tom and Hydraulic Mining in California. R. H. Campbell. Describes this device, used in the early mining days, and gives a brief account of the hydraulic mining period. Ills. 1800 w. Min & Sci Pr—June 25, 1910. No. 15297.

Law.

Mining Law in the German Dependencies (Das Bergrecht in den deutschen Schutzgebieten). W. Westhoff. A review of the mining regulations of the various German colonies. 1300 w. Glückauf—June 18, 1910. No. 15796 D.

Methods.

The Mitchell Slicing System at Bisbee, Arizona. Morris J. Elsing. Describes a modification of the square set method, which reduces timber cost and saves labor. 1500 w. Eng & Min Jour—July 23, 1910. No. 15876.

Placer Mining.

Mobility in Placer Mining. John Power Hutchins. Brief discussion of the importance of factor of mobility in all placer-mining operations. Ills. 1400 w. Mining Mag—July, 1910. No. 15991 B.

Power Plants.

Surface Equipment at Clonan Shaft, Mineville, N. Y. Guy C. Stoltz. Illustrated description of a modern steam operated power plant for an iron mine producing 2000 tons per day. 1500 w. Eng & Min Jour—July 23, 1910. No. 15874.

Power Plants of the Cobalt District, Ontario. Alex. Gray. Illustrated description of the power plants designed to supply the Cobalt mines with compressed air. 2000 w. Min Wld—July 23, 1910. No. 15872.

See Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pumping.

Deep Pumping on the Comstock. A history of the drainage difficulties and methods adopted to overcome them. Ills. 3000 w. Mines & Min—July, 1910. No. 15350 C.

Shafts.

The Tubbing and Re-Tubbing of Shafts. G. R. Thompson. Read before the Nat. Assn. of Col. Mgrs. The meaning of the term as first used and as used by the writer is explained, stresses discussed, forms, strength, applications, etc. Ills. 6000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15569 A.

Shaft Sinking.

The Sinking and Equipping of Penallta Colliery. George G. Hann. From the *Trans. of the S. Wales Inst. of Engrs.* The surface arrangements are illustrated and described in the present number. 1200 w. Col Guard—July 15, 1910. Serial. 1st part. No. 15898 A.

Rapid Shaft Sinking in Butte. C. J. Stone. Notes on methods used in sinking the shaft of the Butte-Alex Scott Copper Co. below the 1400-ft. level. 1000 w. Eng & Min Jour—July 16, 1910. No. 15619.

Stoping.

Stoping at Homestake Mine of South Dakota. John Tyssowski. Describes the methods employed and the cost of excessive shoveling. Ills. 2000 w. Eng & Min Jour—July 9, 1910. No. 15463.

Surveying.

Analytical Geometry in Mine Survey Problems. J. J. Bristol. Gives problems solved by an application of analytical geometry. 2500 w. Min Wld—July 9, 1910. No. 15465.

Timbering.

The Employment of Reinforced-Concrete in Mining (Die Verwendung von Eisenbeton beim Grubenausbau). Herr Viebig. Read at the Düsseldorf Congress. Discusses a number of applications in which this material is replacing timber.

Ills. 12000 w. Glückauf—June 18, 1910. No. 15792 D.

Ventilation.

Mine Resistance. Thomas W. Fitch. Reviews the laws governing the flow of fluids and explains method of measuring resistance to the flow of air. 4000 w. Mines & Min—July, 1910. No. 15344 C.

Test of a Fan Driven by a Three-Phase Motor (Untersuchung eines Drehstrommotor-Ventilatorantriebes mit maschineller Umdrehungsregelung). Describes the plant and the test, and gives results. Ills. 2000 w. Glückauf—June 18, 1910. No. 15795 D.

ORE DRESSING AND CONCENTRATION.

Briquetting.

Iron-Ore Briquetting and Agglomerating in Germany (Der gegenwärtige Stand der Eisenerz-Brikettierung und -Agglomerierung in Deutschland). G. Franke. Read at the Düsseldorf Congress. Describes various processes in use. 2500 w. Stahl u Eisen—June 22, 1910. No. 15777 D.

Crushing.

Crushing Machines for Cyanide Plants. Mark R. Lamb. Remarks on the changes in the cyanide process, reviewing the various machines for crushing, grinding, etc. 1400 w. Bul Am Inst of Min Engrs—July, 1910. No. 15860 F.

Milling and Crushing Exhibits at the Brussels Exhibition (Müllerei und Hartzerkleinerung auf der Weltausstellung in Brüssel). Carl Naske. A preliminary report. Serial. 1st part. 1000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15950 D.

Electrostatic Separation.

Electrostatic Separation of Minerals in Ores. Henry A. Wentworth. Describes the Huff electrostatic separators and the principles on which they are based, illustrating plants where they are successfully used. 2500 w. Eng & Min Jour—July 2, 1910. No. 15353.

Filters.

The "Turn-Over" Mechanically-Cleaned Filter. Illustrated description of a filter in the form of a cylindrical barrel, lying with its axis horizontal and so arranged that it may be rotated. 1800 w. Engng—June 10, 1910. No. 15498 A.

Gold Milling.

Progress in Ore Treatment at Kalgoorlie. M. W. von Bernewitz. Abstracted from "The Gold Mines of Western Australia." Reviews the rapid progress made since 1893. 3000 w. Min & Sci Pr—June 25, 1910. No. 15295.

Jigs.

Methods of Modern Ore Concentration. Charles C. Christensen. Describes two plants, one employing the Hancock type of jig, and one the Hartz type of jig. Gives flow sheets. 1200 w. Min Wld—July 9, 1910. No. 15466.

Magnetic Concentration.

See Quebec, under IRON AND STEEL.

Roasting.

Chloridizing Roasting of Cuprous Pyrites Cinders. Sten Lilja. Illustrated detailed description of the Henderson process for the extraction of copper from pyrite cinders. 5000 w. Met & Chem Engng—July, 1910. No. 15424 C.

Sampling.

Accuracy of Mechanical and Riffle Ore Samples. Louis D. Huntoon. Discusses the requirements of mechanical ore samplers, the cause of inaccurate results with riffles, etc. 2500 w. Eng & Min Jour—July 9, 1910. No. 15460.

Slimes Treatment.

The Elements of Slime Concentration. Walter McDermott. Read before the Inst. of Min. & Met. A statement of certain elements, established by practice, with conclusions indicating the most promising direction for improvements. 7200 w. Met & Chem Engng—July, 1910. No. 15427 C.

Stamp Mills.

Power Required in Stamp Milling Operations. A. W. Warwick. A study of the power consumed by a stamp mill, how it is utilized and how to calculate the power required by any stamp. 3000 w. Min Wld—July 23, 1910. No. 15873.

MISCELLANY.

Australasia.

The Australasian Institute of Mining Engineers. A report of the Congress at Mount Morgan, Central Queensland, with the presidential address, papers read, etc. Ills. 13000 w. Aust Min Stand—June 8, 1910. Serial. 1st part. No. 15688 B.

Dusseldorf Congress.

The International Congress of Mining, Metallurgy and Practical Geology at Dusseldorf Germany. Interesting account of this congress and the entertainment furnished. 3000 w. Eng News—July 14, 1910. No. 15504.

The International Congress of Mining, Metallurgy and Applied Geology. Charles Kirchhoff. Gives abstracts of important papers at Dusseldorf on recent practice in iron and steel and related industries. 12000 w. Ir Age—July 14, 1910. No. 15574.

International Congress of Mining and Metallurgy at Dusseldorf. First of a series of articles on the work of this congress. The present number reviews the work of the Mining Section. 2500 w. Engr, Lond—July 1, 1910. Serial. 1st part. No. 15563 A.

Glacial Lakes.

Glacial Lakes and Their Relation to Mining. Arthur Lakes. Drawings and descriptions of these amphitheaters, formed by erosion, where veins are often exposed. 1700 w. Min Wld—July 16, 1910. No. 15642.

Louisiana.

Conserving Mineral Resources of Louisiana. C. Willard Hayes. Introductory remarks, with a discussion of the various economic minerals of the state and the conservation policy that should be adopted. 4400 w. Mfrs' Rec—June 30, 1910. No. 15288.

Ore Deposits.

The Ultimate Source of Ores. Charles R. Keyes. Considers the four phases of primary ore-genesis, discussing each in detail. 6800 w. Bul Am Inst of Min Engrs—July, 1910. No. 15859 F.

Economies of Secondary Enrichment. A. M. Finlayson. A study of the chemical and physical processes in the enrichment of typical ores. 3500 w. Min & Sci Pr—July 16, 1910. Serial. 1st part. No. 15824.

Refractory Materials.

Measurement of the Thermal Conductivity of Fireclay. Describes a method developed by Dr. J. K. Clement and W. L. Egy, and described in Bul. 36 of the Engng Ex. Station of the Univ. of Illinois., illustrating its application by example. Ills. 1800 w. Met & Chem Engng—July, 1910. No. 15420 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

The Block Signal Question. James Brandt Latimer. Explains the nature of the block system, and the manual and automatic blocking, discussing features and efficiency of the two systems. 5500 w. Eng News—June 30, 1910. No. 15396.

British Methods of Operating Single Tracks. Explains the use of the train staff, and the block system, and the electrically controlled token system. Ills. 2000 w. Can Engr—July 21, 1910. No. 15864.

Train Service.

The Summer Train Service. A review of the summer service on British railways. 1600 w. Engr, Lond—July 1, 1910. No. 15562 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Undesired Quick Action. Shows the causes and conditions likely to produce undesired quick action. Also describes an invention for preventing it. 2800 w. Ry & Loc Engng—July, 1910. No. 15330 C.

Electrification.

The Electrification of Railways. George Westinghouse. Calls attention to the necessity of the early selection of a system for universal use. Ills. 10500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15834 F.

Economies of Railway Electrification. William Bancroft Potter. A study of the problem, discussing conditions determining railway equipment, interurban railways, etc. Ills. 3500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15835 F.

The Electrification of the Lapland Railway. Gives details of the plans with a map of the district affected. 2500 w. Engng—July 1, 1910. No. 15545 A.

Freight Cars.

Steel in Freight Car Construction. C. A. Seley. An illustrated discussion of car design and the composite construction of freight cars. 3000 w. Ry Age Gaz—July 8, 1910. No. 15472.

New Tank Car. Illustrated description of a design built by the Chicago Steel Car Co., which lessens the height of the center of gravity of the loaded car 18 inches. 600 w. Ry Age Gaz—July 15, 1910. No. 15611.

Locomotive Boilers.

Report No. 6, for All Countries Except Russia, America, Austria, Hungary, Roumania, Bulgaria, Servia, Turkey, France, Belgium, Italy, Spain, Portugal and Great Britain, on the Question of Improvements in Locomotive Boilers. Karl Steinbiss. Ills. 39000 w. Bul Int Ry Cong—June, 1910. No. 15996 G.

The New Water-Tube Boiler under Test in the High-Speed Locomotive 2.741 of the Northern of France (La nouvelle Chaudière à Foyer à Tubes d'Eau à l'Essai sur la Locomotive à grande Vitesse. 2.741 de la Compagnie du Nord). J. Kœchlin. Illustrated description. 3000 w. Rev. Gen d Chemins de Fer—June, 1910. No. 15716 G.

Locomotive Construction.

Report No. 6, for Great Britain, on the Question of the Use of Special Steels. Wilson Worsdell. Considers the use of special steels of high resistance in the making of the various parts of locomotives and rolling stock. 3600 w. Bul Int Ry Cong—June, 1910. No. 15994 G.

Locomotive Frames.

Locomotive Frame Construction. H. T. Bentley. Read before the Am. Ry. Mas. Mech. Assn. Introductory to discussion of what can be done to increase the life of engines between general repairs. 2000 w. Am Engr & R R Jour—July, 1910. No. 15480 C.

Locomotive Front Ends.

Front End Tests. Gives results of a seies of tests on the locomotive testing plant at Altoona to determine the best arrangement of front ends for Pennsylvania Atlantic type locomotives, classes E 2a and E 3a. Ills. 3000 w. Am Engr & R R Jour—July, 1910. No. 15474 C.

Tests of Self-Cleaning Front Ends, Pennsylvania Railroad. A detailed report of tests made on a E 2a locomotive and E 3a. 2000 w. Ry Age Gaz—July 15, 1910. No. 15614.

Locomotive Fuels.

Oil Fuel for Locomotives, with Special Reference to the Coal-Tar Oil Tests of the Prussian State Railways (Ueber Oelfeuerung für Lokomotiven, mit besonderer Berücksichtigung der Versuche mit Teerölzusatzfeuerung bei den preussischen Staatsbahnen. L. Sussmann. Discusses the utilization of gas-works by-products. Ills. Serial. 1st part. 3000 w. Glasers Ann—June 1, 1910. No. 15922 D.

Locomotive Operation.

Education as an Essential of Fuel Economy. W. C. Hayes. Read before the Am. Ry. Mas. Mech. Assn. Deals with the instruction and educational development of enginemen. 2200 w. Am Engr & R R Jour—July, 1910. No. 15478 C.

Locomotive Repairs.

Locomotive Running Repairs. Remarks on the improvements in locomotive repair shops, and on the readjustment of valve gear. Ills. 2500 w. Ry & Loc Engng—July, 1910. No. 15329 C.

Locomotives.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives tables arranged with respect to total weights, and arranged with respect to classes and weights. 3000 w. Am Engr & R R Jour—July, 1910. No. 15477 C.

Crampton Locomotives. Alfred R. Bennett. An article, supplementary to Herr v. Gaiser's work on these locomotives, dealing with the rebuilt and the 4-wheeled classes. Ills. 1500 w. Engr, Lond—July 1, 1910. No. 15561 A.

Locomotives at the Brussels Exhibition. Illustrates and describes extra powerful grade and express locomotives for heavy trains on the Belgian State Rys., and for the Bavarian State Rys. Also editorial. 3500 w. Engr, Lond—June 24, 1910. Serial. 1st part. No. 15547 A.

Mallet Articulated Locomotive 2-8-8-2 Type. New locomotives for the Norfolk & Western Ry. are illustrated and described. 800 w. Am Engr & R R Jour—July, 1910. No. 15476 C.

Pacific and Consolidation Type Locomotives. Illustrated detailed description of recent locomotives of these types for the Chicago & Northwestern railway. 800 w. Am Engr & R R Jour—July, 1910. No. 15475 C.

Mallet Compound Locomotive for the Natal Government Railways. Illustrated detailed description of engine doing satisfactory work on heavy grades. Plate. 1000 w. Engng—July 8, 1910. No. 15672 A.

Consolidation Type Locomotive for the South Manchuria Railway. Illustrated description of a powerful engine, one of twelve recently completed. 700 w. Engr, Lond—July 15, 1910. No. 15978 A.

Locomotive Superheating.

Locomotive Superheaters. Data and illustrated descriptions of successful types. 3000 w. Mach (Ry. Ed.)—July, 1910. No. 15383 C.

Locomotive Valve Gears.

The Kinematics of Two-Eccentric Link Motions (Ein neues Verfahren zur Ausmittlung der Zweiexzenter-Kulissensteuerungen). L. Baudiss. Gives a new method for the solution of Stephenson, Allan and Gooch link-motion problems. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—June 3, 1910. No. 15925 D.

Passenger Cars.

See also Heat Insulation, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Shops.

New Shops of the Central of Georgia Ry., Macon, Ga. Illustrated detailed description of shops located on uneven ground near the center of a city, and their equipment. 3500 w. Ry & Engng Rev—July 16, 1910. No. 15643.

Locomotive and Car Shops of the National Trans-Continental, Winnipeg, Canada. Plan and description of shops and equipment. 4000 w. Ry Age Gaz—July 22, 1910. No. 15831.

The Eastleigh Locomotive Works of the London and South-Western Railway Company. An illustrated account of the new shops and some of the principal tools and machines acquired. Plate. 2500 w. Engr, Lond—July 15, 1910. Serial. 1st part. No. 15976 A.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrated detailed description of methods of driving-box manufacture used at the Juniata shops. 3000 w. Mach (Ry. Ed.)—July, 1910. No. 15382 C.

Train Resistance.

Feight Train Resistance; Its Relation to Average Car Weight. Edward C. Schmidt. Read before Am. Ry. Mas. Mech. Assn. A record of tests planned to determine the resistance of freight trains under the usual conditions of operation. 1200 w. Am Engr & R R Jour—July, 1910. No. 15479 C.

Wheels.

Unevenly Chilled and Untrue Car Wheels. Thomas D. West. Read before the Am. Soc. for Test. Mat. Explains existing defects and proposes a method of correcting them. 1500 w. Ir Age—June 30, 1910. No. 15304.

NEW PROJECTS.

Cape-to-Cairo.

Present Situation and Prospects of the Cape-to-Cairo Railway (Stand und Aussichten der Kap Kairo Bahn). Richard Hennig. A review of work already done and of plans for the completion of the line. Ills. 3000 w. Tech u Wirt—June, 1910. No. 15961 D.

Mexico.

The Southern Pacific of Mexico Railroad. L. A. Waterbury. Illustrates and describes a railway system which will connect the City of Mexico with the western portion of the United States. 2000 w. Eng News—July 28, 1910. No. 16025.

Switzerland.

The Bernese Alpine Railway (Berner-Alpenbahn). A. Zollinger. Describes the line which includes the Lötschberg tunnel. Ills. Serial. 1st part. 2000 w. Schweiz Bau—June 18, 1910. No. 15908 B.

PERMANENT WAY AND BUILDINGS.

Bridges.

Report No. 10 for Austria and Hungary on the Question of Stengthening the Bridges with a View to Increasing the weight of Locomotives and the Speed of Trains. M. Maurer. Discusses the suitable strengthening of existing metal bridges proportionately to the increase in weight of locomotives and speed of trains. Ills. 17600 w. Bul Int Ry Cong—June, 1910. No. 15992 G.

Construction.

Copper River and Northwestern Railroad, Alaska. L. W. Storm. Describes a 200 mile railroad under construction at a cost of $13,000,000, and the difficulties encountered. Ills. 3000 w. Eng & Min Jour—July 9, 1910. No. 15464.

Open Cuts.

Erie's Four-Track Open Cut. Illustrated account of the construction of the open cut through Bergen Hill, Jersey City, to be used instead of the tunnel, for passenger service. 1000 w. Ry & Loc Engng —July, 1910. No. 15328 C.

Round Houses.

American Locomotive Terminals. William Forsyth. Gives general plan of the East Altoona, Pa., engine house with description of the oganization and work. 3500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15838 F.

Engine House Practice, or the Handling of Locomotives at Terminals to Secure Continuous Operation. F. H. Clark. Describes features of design and equipment considered good practice in the United States. Ills. 2500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15837 F.

Handling Locomotives at Terminals. Frederic M. Whyte. Discusses practice along certain lines in the United States and Canada, with suggestions. 6000 w. Jou Am Soc of Mech Engrs—July, 1910. No. 15836 F.

Terminals.

Design of Terminals for Mechanical Freight Handling. H. McL. Harding. Editorial letter, explaining the advantages of the overhead method, and offering suggestions. 2500 w. Ry & Engng Rev—July 2, 1910. No. 15292.

New Chicago Station of the Chicago & North Western. An illustrated article giving some facts relating to the construction of one of the largest terminals in the United States. 3000 w. Ry Age Gaz—July 15, 1910. No. 15615.

See also New York, under CIVIL ENGINEERING, Waterways and Harbors.

Track Construction.

Report No. 9, for All Countries Except Austria, Hungary, Bulgaria, Roumania, Servia, Turkey, America, and Great Britain, on the Question of Stengthening the Track with a View to Increasing the Weight of Locomotives and the Speed of Trains. M. Blum. 7200 w. Bul Int Ry Cong—June, 1910. No. 15995 G.

See also Earthwork, under CIVIL ENGINEERING, Construction.

Track Maintenance.

Methods and Costs of Surfacing and Smoothing Track. D. A. Wallace. Suggestions and records of work. 2500 w. Engng-Con—July 27, 1910. No. 16018.

Turntables.

Turntable for Mallet Locomotives. Illustrated description of a motor-driven transfer type turntable designed by Frank H. Adams. 700 w. Ry Age Gaz—July 1, 1910. No. 15365.

TRAFFIC.

Bills of Lading.

The Bills of Lading Controversy. Discusses the bill for making railway companies liable for the acts of their agents in issuing order bills of lading. 2500 w. Ry Age Gaz—July 15, 1910. No. 15612.

Car Distribution.

Car Distribution. N. D. Ballantine. Condensed from a lecture to the students of "Railway Economics," Univ. of Mich. Discusses the problems of this service, the requirements, etc. 4800 w. Ry Age Gaz —July 15, 1910. No. 15610.

Car Interchange.

Interchange of Freight Cars on the Basis of Master Car Builders' Rules of Interchange vs. Run, Repair or Transfer. R. L. Kleine. A study of the question, introducing a general discussion. 21500 w. Pro Ry Club of Pittsburgh—April 22, 1910. No. 15816 C.

Freight Damages.

Loss and Damage—Causes and Remedies. Otto Best. Abstract of an address before the Nashville, Tenn., Assn. of R. R. Officers. Follows a shipment of merchandise from loading station to destination, pointing out the causes of waste and loss. 2500 w. Ry Age Gaz—July 8, 1910. No. 15470.

Locomotive Pooling.

Handling Engines. H. H. Vaughan. Discusses the desirability of pooling in passenger and in freight service. 1800 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15839 F.

Perishable Freight.

Report No. 2, for All Countries Except those Using the English Language, on the Question of Perishable Goods. Richard Bloch. Considers suitable measures for developing the traffic in perishables. 46500 w. Bul Int Ry Cong—June, 1910. No. 15993 G.

MISCELLANY.

Abyssinia.

The Djibouti-Addis-Abera Railway (Note sur la Ligne de Djibouti à Addis-Abeba). R. Godfernaux. Describes in detail the construction and operation of the first railway in Abyssinia. Ills. 8000 w. Rev Gen d Chemins de Fer—June, 1910. No. 15715 G.

Australia.

Australia's Railway System and Some of Its Problems. Jas. Alex. Smith. Extracts from a presidential address to the Victorian Inst. of Engrs. under the title "National Issues in Australian Railway Engineering." 3500 w. Eng News—July 14, 1910. No. 15590.

Holland.

Transportation and Traffic in Holland. Logan G. M'Pherson. A preliminary report to the Nat. Waterways Com. Facts in regard to the transportation and traffic and the revenues of the operating companies. 2000 w. Ry Age Gaz—July 29, 1910. No. 16041.

International Congress.

International Railway Congress. A report of the meeting in Berne, Switzerland, which opened July 5th. 2500 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15681 A.

Management.

Deadwood in Railway Service. N. F. Dougherty. Discussion of employees below the position of superintendent, and the importance of worth selection instead of chance selection. 2500 w. Ry Age Gaz—July 22, 1910. No. 15830.

Profits.

Profits of American Railways, as Illustrated by the Illinois Central. Howard G. Brownson. A. study of the cash investment and the profits made. 6000 w. Ry Age Gaz—July 1, 1910. No. 15360.

Scandinavia.

Scandinavian Railways (Auf skandinavischen Eisenbahnen). Herr von Mühlenfels. A general description of the railway sytems of Sweden and Norway. Ills. 14000 w. Glasers Ann—June 15, 1910. No. 15924 D.

STREET AND ELECTRIC RAILWAYS.

Brake Shoes.

Brake Shoe Standardization. J. A. Panton. Abstract of a paper before the Tram. & Lgt. Ry's. Assn. Calls attention to waste in connection with brake heads and blocks, and discusses the properties of various types of brake blocks, suggesting a standard design. 4000 w. Elect'n, Lond—June 24, 1910. No. 15517 A.

Canal Haulage.

Novel Electric Towing Locomotive for Canal Locks. Herbert Brackett. Illustrates and describes the novel locomotive by which vessels are towed through the Bremen locks. 700 w. Sci Am—July 9, 1910. No. 15415.

Capacity.

A Method for Determining the Adequacy of an Electric Railway System. R. W. Harris. A study of practical working conditions during the peak periods. 5000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15275 F.

Car Barns.

Car Depot of the Paris Tramways Company. Illustrated detailed description. 2500 w. Tram & Ry Wld—July 7, 1910. No. 15805 B.

Car Wheels.

The Latest Development in Car Wheels for Electric Railways. V. S. Yarnell. Read at meeting of St. Ry. Assn. of N. Y. State. Describes the methods of manufacture employed by the Carnegie Steel Co. in the manufacture of Schoen solid forged and rolled steel wheels. 2500 w. Elec Ry Jour—July 2, 1910. No. 15317.

Controllers.

Recent Developments in Multiple-Unit Control and Other Electric Railway Apparatus. Clarence Renshaw. Abstract of a paper read before the St. Ry. Assn. of N. Y. State. Explains the advantages of multiple-unit control, and illustrates and describes apparatus. 2500 w. Elec Ry Jour—July 2, 1910. No. 15320.

Detroit.

See Valuation, under STREET AND ELECTRIC RAILWAYS.

Feeders.

See Line Design, under ELECTRICAL ENGINEERING, TRANSMISSION.

Hamburg.

The Hamburg City and District Railways (Die Hamburger elektrischen Stadt- und Vorortebahnen). E. A. Ziffer. A brief description of their extent and operation. Ills. 5000 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—June, 1910. No. 15760 F.

Headlights.

Headlight-Tests. C. Francis Harding

and A. N. Topping. A report of tests carried out by the Engineering Schools of Purdue University to determine the effect of powerful headlights upon the interpretation of signals and on the ability to recognize obstacles upon the tracks. 8000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15281 F.

Interurban.

Winnipeg, Selkirk & Lake Winnipeg Interurban Railway. Brief illustrated description. 1600 w. Elec Ry Jour—July 2, 1910. No. 15316.

The 1200-Volt D. C. Interurban Lines of the Milwaukee Electric Railway & Light Company. Illustrated description of the scheme of electrification, rolling stock, substations, and construction. 3500 w. Elec Ry Jour—July 16, 1910. No. 15606.

Locomotives.

The Design of the Electric Locomotive. N. W. Storer and G. M. Eaton. A statement of the problem as viewed by the authors, discussing a few of the fundamental principles on which the design should be based. Ills. 8500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15283 F.

Edison Electric Locomotive No. 2. Frederick A. Scheffler. Illustrated description. 1200 w. Elec Rev, N Y—July 23, 1910. No. 15868.

Steam Turbine Electric Locomotive. Illustrated description of the Reid-Ramsay turbo-electric locomotive. 700 w. Engr, Lond—July 8, 1910. No. 15683 A.

The Reid-Ramsay Electro-Turbo Locomotive. Illustrations with brief description. 300 w. Engng—July 8, 1910. No. 15674 A.

See also Canal Haulage, under STREET AND ELECTRIC RAILWAYS.

Melbourne.

Melbourne Electric Transit. An illustrated account of the Prahran-Malvern tramway, recently completed at a cost of £87,000. 3000 w. Aust Min Stand—May 25, 1910. No. 15503 B.

Monorail.

The Elementary Theory of the Gyroscope in the Brennan Monorail Car. Edward V. Huntington. A clear statement of the elementary principles of the gyroscope, and its application to the Brennan monorail car. Ills. 4000 w. Eng News—July 21, 1910. No. 15804.

Motor Gears.

Railway Motor Gears and Pinions. T. W. Williams. Abstract of a paper read at meeting of the St. Ry. Assn. of N. Y. State. Investigates causes of rapid wear and means of strengthening. 3000 w. Elec Ry Jour—July 2, 1910. No. 15318.

Operation.

Regulation of Transportation Service by the Metropolitan Street Railway, New York. A description of the transportation service and its regulation. 5500 w. Elec Ry Jour—July 2, 1910. No. 15315.

Improved Operation of the Brooklyn Bridge. Explains changes that have brought about excellent results in expediting the congested traffic. Also editorial. 3000 w. Eng Rec—June 11, 1910. No. 14690.

Power Economy in Electric Railway Operation—Coasting Tests on the Manhattan Railway, New York. H. St. Clair Putnum. Describes tests made on the Manhattan Elevated Division, New York, in which a clock was used to record the amount of coasting employed, the object being to obtain a better manipulation of the trains with resulting economy in the use of power. 4500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15276 F.

Economy of Car Operations. Cyril J. Hopkins. Aims to show quantitatively the value of coasting in terms of change in average speed, and running time, and to discuss the value of anti-friction bearings. Ills. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15277 F.

Service.

The Street Railways of Some German Cities and of Some American Cities. A comparison of the service, to the disadvantage of American lines. 3500 w. Eng News—July 28, 1910. No. 16029.

Single-Phase.

The Single-Phase Railway Between Rotterdam, the Hague, and Scheveningen. C. Van Langendonck. Illustrated description. 2000 w. Ry Age Gaz—July 8, 1910. No. 15471.

Subways.

Boston Elevated Railroad Company's New Tunnel. Illustrates and describes the uses made of electricity in the construction of the Cambridge subway. 4000 w. Elec Wld—July 28, 1910. No. 16019.

Report on Pittsburgh Subway. Bion J. Arnold. Abstract of a preliminary report on the possibilities for rapid transit. 2000 w. Ry Age Gaz—July 22, 1910. No. 15832.

Track Construction.

Standardization of Track Construction in Paved Streets. Benjamin E. Tilton. Abstract of paper read before the St. Ry. Assn. of N. Y. State. Discusses the foundation, substructure, and superstructure, and the general standards appliable to cities of ordinary size. 3000 w. Elec Ry Jour—July 2, 1910. No. 15319.

Trolley Lines.

Brooklyn Line Department—Efficiency Features of Construction and Maintenance. Illustrates and describes the construction used for the ordinary type of overhead trolley lines, with an explanation of the system of records. 2000 w. Elec Ry Jour—July 23, 1910. No. 15823.

Valuation.

The Appraised Value of the Electric Street Railways of Detroit, Mich. Abstract of the report of Frederick T. Barcroft. 3500 w. Engng-Con—July 6, 1910. No. 15495.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to ***give the number*** of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encóuragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins fur die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Corrosion.

The Corrosion and Preservation of Iron and Steel. By Allerton S. Cushman and Henry A. Gardner. Size, 9 by 6 in.; pp., 373. Ills. Price, $4. New York: McGraw-Hill Publishing Company.

A large part of this work is devoted to the presentation of the results of Dr. Cushman's researches in the laboratory of the United States Office of Public Roads which led to the formulation of the electrolytic theory of corrosion. All of this material has already been published in official bulletins but not in such complete detail as in the present volume. Dr. Cushman's collaborator is Director of the Scientific Section of the Paint Manufacturers' Association of the United States. The practical application of the electrolytic theory of corrosion to the problem of preservation is clearly demonstrated, and the second part of the book summarizes present knowledge as to the properties of the various pigments, paints and other protective coatings as stimulators or inhibitors of corrosion. The chapter headings are: The Problem of Corrosion; Theory of Solution; Theory of Corrosion; Application of Electrolytic Theory; The Inhibition and Stimulation of Corrosion; The Technical Protection of Iron and Steel; Relation of Pigments to the Corrosion of Iron; Recent Field Tests on Protective Coatings for Iron and Steel; Paints for Various Purposes; The Testing and Design of Protective Paints; Properties of Pigments; and The Properties of Paint Vehicles. Appendices give a bibliography and a report of a discussion before the American Institute of Mining Engineers on the Corrosion of Water Jackets of Copper Blast Furnaces. The volume is appropriately dedicated to the memory of Dr. Charles B. Dudley.

Roads.

Dust Preventives and Road Binders. By Prévost Hubbard. Size, 9 by 6 in.; pp., 416. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

This timely work aims to furnish road engineers with a working knowledge of the characteristic properties of dust preventives and road binders now in use, and to develop certain fundamental principles relative to their selection and application. The conclusions presented are based upon five years' field and laboratory experience as Assistant Chemist in the United States Office of Public Roads. The author admits that practice in dust prevention has not yet been standardized, that there is much yet to be learned regarding the effect of certain properties of road binders upon their practical usefulness. It is unquestionable, however, that an authoritative summary of the established facts was needed, which the present volume seems adequately to offer.

Shop Practice.

Engineering Workshop Machines and Processes. By F. zur Nedden. Translated and Revised by John A. Davenport. Size, 8¾ by 5½ in.; pp., 216. Ills. Price, $2. New York: D. Van Nostrand Company.

The sub-title, "A Handbook for the Use of Students and Others Taking the Workshop Training Recommended by the Institution of Civil Engineers," indicates the scope of this work. It is a translation and adaptation to suit the needs of English engineering apprentices of certain parts of a German work written to assist during their "practical year" the "volunteers" who, in the German educational system, interpolate twelve months' workshop experience between school and university. The intention of the author and translator has been to set out in a condensed but intelligible form those matters which a young engineer entering a shop for the first time will frequently find to be assumed by those around him in the shop as known already. The subjects dealt with, after a brief introductory chapter on the efficiency of engines and machines, include: the modern engineering works; materials of construction; foundry and pattern shop; forging; the machine shop; measuring and marking-off; and fitting, erecting and testing. An introduction is contributed by Sir Alexander B. W. Kennedy, and an appendix contains the report on the education and training of engineers adopted by the Council of the Institution of Civil Engineers.

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